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The Probation Officer: A Forensic Scientist*

*Ben S. Meeker, Chicago, Ill.***

It is with some trepidation that I approach this subject. I am sure that the concept implicit in the title of my paper can and probably will be challenged. Indeed, as I attempted to organize my thinking about the concept of the probation officer as forensic scientist I realized that the term "forensic" should perhaps appear in quotations.

However, whether or not one agrees with the idea suggested in the title, I believe there are certain developments which tend to indicate that the function of the probation officer is gradually being more clearly defined and his role as a kind of "forensic scientist" better delineated.

Perhaps the term "forensic" is a misnomer. Certainly the probation officer operates in a different relationship to the Court than the "forensic scientist" in the adversary proceeding under the rules of evidence which govern the trial process. I shall take my cue, however, from an editorial in the first issue of the Journal of "Forensic Sciences" which says, "that part of the knowledge possessed by any science which is utilized in the administration of justice in any way, either in criminal or civil matters, may be referred to as forensic in character."

Scientific knowledge from a variety of social science disciplines comprises the basis upon which the skills of the probation officer "expert" are formed. Typically in Anglo-American courts the probation officer is an agent of the

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** Chief U. S. Probation Officer, U. S. District Court, Northern District of Illinois.

court who operates by order of the court, is responsible to the court and is assigned specific duties. My comments will be confined primarily to the probation officer attached to courts of criminal jurisdiction rather than juvenile courts.

Expert

As with this term "forensic" so with the term "expert," I shall use it in its broader application as one possessed of special knowledge. I realize that the commonly accepted concept of "forensic expert" ordinarily refers to the special legal status of an individual appointed to testify during a trial on a specific bit of evidence by bringing to bear some highly specialized clinical knowledge about a chemical analysis, engineering principle, medical symptom or similar information relevant to a criminal act and admissible as evidence in the trial.

If we limited the term "forensic expert" to the witness who appears during the adversary trial procedure, we would, of course, eliminate the probation officer in courts which operate under the rules of evidence of our Anglo-American system with its clear-cut cleavage of the trial into two parts; first, a process governed by strict rules of evidence leading to a finding, and second, a procedure concerned with determining sentence.

The probation officer in our system of courts does not appear during the trial process leading to a finding.[1] He appears only following a finding and his function is to search for facts pertaining to the nature of the offender's character, background and potential suitability for probation. This requires a high degree of skill and a fund of expert knowledge. It is this concept of expert that I wish to develop.

I think we might characterize our times as an age of experts. Perhaps nowhere is this better illustrated than in the continuing controversy over the matter of criminal responsibility. The increased understanding of the nature of behavior, its complexities and the dynamics of psychiatry, psychology, sociology and all the social sciences has led to

[1] In many European countries there is no cleavage in the trial process and if a probation officer is used, he must testify along with other witnesses.

more and more concern over the legal-philosophical problem of moral responsibility.

Efforts to broaden the interpretation of the M'Naghten Rule and the interesting and highly controversial decision of Judge Bazelon in the Durham (1) case has prompted increased discussion of this whole problem. In this decision the traditional issue of responsibility in terms of a knowledge of right and wrong gives way to a clinical evaluation of sanity. I cite this primarily to illustrate the continuing efforts of society to reduce problems in the legal, social and emotional realm to a more exact science. Not only is the forensic expert during the adversary proceedings of the trial preoccupied with efforts to define more exactly the nature of evidence and to discover more scientific methods for interrogation and evaluation of the facts in evidence, but the court through its probation arm has become interested in an evaluation of the offender in relation to his total personality and character. This is where the scientific skill of the probation officer as part of a team of experts must be recognized.

The probation officer is not a lawyer. He is only incidentally involved in the situation with regard to evidence. His primary concern is not with the legal question of culpability or criminal responsibility. This is a legal matter for the court to determine, assisted by the prosecutor and the defense counsel. As we have indicated, it is only after a finding of guilt that the probation officer enters the scene.

It is at this stage in the court process that the utilization of knowledge and skill possessed by competent probation officers can contribute much to the ends of justice.

Growing Professionalization

As one reviews the development of probation one notes a growing number of attributes characteristic of a professional endeavor. One of these attributes can be observed in the quality of skill reflected in presentence reports prepared by well-trained probation officers.

Another attribute appears in the quality of supervision or probation counselling now being conducted by probation departments where personnel qualifications are high. Where supervision is carried on in accordance with sound principles

of casework counselling and imaginative utilization of community resources, success can be demonstrated with a high percentage of probationers.[1]

However, at this point I would like to analyze briefly the role of the probation officer in relation to the presentence investigation. Perhaps it would be well at the onset to contrast his role with that of the trial expert.

Contrasts Between Experts

In contrast with the expert witness who testifies during the adversary proceedings of the trial, the probation officer "expert" is not bound by rules of evidence. Thus, unlike the forensic expert testifying during the trial procedure who may experience great difficulty in applying a clinical method in court under rules which make it hard for him to explain how he arrived at a decision—except through a tedious process of lengthy hypothetical questions and answers—the probation officer may give in full clinical array expert opinions and the bases for value judgments and conclusions derived from the facts he has discovered.

Objective facts regarding birth, family status, education, marital history, employment record, any known previous delinquency and whatever findings are known regarding the mental, medical, emotional, psychological and social history form the basis for his conclusions.

Another difference between the probation officer expert and the adversary forensic expert stems from the absence of cross-examination, since guilt is not at issue. His freedom from cross-examination, however, is a two-edged sword. On the one hand, if used professionally it is a source of strength. On the other hand, it may be a source of error if used by inept.

The power of the Court to award probation is a statutory power. Since in the absence of any limiting power upon the judge to award probation, except as provided by statute (i. e., where a certain crime may be barred from probation),

[1] Excellent clinical case material is available, however, to demonstrate the scientific validity of good casework supervision as a technique for protecting the community through rehabilitation of selected offenders.

the sentencing judge, within the statutory limitations of the penal code he is administering, may avail himself of any and all information concerning the offender which will guide him toward a proper sentence. It does not appear that there is any legal basis for cross-examining the judge with regard to why he awards either probation or a prison sentence, so long as probation or the sentence come within the prerogatives of the statute and no error can be shown. By this same logic the probation officer, who in reality is merely an extension of the eyes, ears and mind of the judge, is not subject to cross-examination save by assent of the court. Long accepted legal practice suggests that the sentencing power of a judge may not be attacked except where cruel or unusual punishments are inflicted, or for reasons of error.

A third difference between the probation officer "expert" and the adversary forensic witness is a basic difference in approach. The probation officer is not preoccupied with an abstracted bit of behavior defined by law as an overt criminal act. The adversary expert witness is primarily called upon to testify relating to an isolated act or series of related acts or conditions surrounding a specific alleged crime.

The probation officer, on the other hand, is concerned with the total individual. He is expected by the court to regard the crime as but one aspect of a profound and complicated system of physical, mental, emotional and social responses which characterize the individual offender. The probation officer is, therefore, concerned with the crime only insofar as it has been proven or admitted to, and, of course, is a major indication of social maladjustment.

I submit, therefore, that since the probation officer is not bound by rules of evidence, is not subject to cross-examination except by consent of the court, and is not preoccupied with any isolated act or series of acts, but must be concerned with the total personality and behavior pattern of the individual, he must, of necessity, be a highly trained, skilled and, if you please, competent expert. This is no job for an amateur. The day of appointing the *retired public official*, the *politically connected precinct captain* or the *well-meaning soul with the undisciplined mind*, has no place in such work.

Perhaps a definition of probation will focus additional light upon the complex nature of this new mode of handling offenders. It is not easy to define probation, though a definition published by the old National Conference of Law Observance and Enforcement in 1931 is perhaps one of the best statements on the subject. Probation is here defined as:

> "A process of *treatment* prescribed by the court for persons convicted of offenses against the law, during which the individual on probation lives in the community and regulates his own life under conditions imposed by the court and subject to the supervision of the probation officer." (2)

The great significance of this definition is to be found in a recognition of probation as a *process of treatment* undertaken by the probation officer through the medium of supervision. Probation as herein contemplated is not punishment. It is not clemency. It is not an act of mercy. It is not a pardon. Above all, it is not just another chance. It is, rather, a *process of treatment* aimed at effecting a readjustment within the community setting of the attitudes, habits and capabilities of the offender (3).

In probation the diagnostic process is developed through the presentence investigation. If we conceive of probation as a method of corrective treatment and rehabilitation we must concede that the first step toward adequate treatment is correct diagnosis. It is now well recognized that only through careful selection of offenders, followed by intensive skilled supervision, can probation as a correctional treatment measure succeed. The late Judge Lewis B. Schwellenback, after noting the serious violation of a personable offender he had just placed on probation without a presentence investigation, commented "The knowledge of the life of a man, his background and his family, is the only proper basis for determination as to his treatment. There is no substitute for information. The sentencing judge . . . has the tools with which to acquire that information. Failure to make use of these tools cannot be justified." (4) Obviously, a good presentence investigation will not only present positive evaluations in those cases in which probation seems indicated,

but will prove of equal value to the court in screening out the defendant who may be a menace to the community or who, for various reasons, appears not to be amenable to probation supervision.

The Federal Probation Statute provides that, "It shall be the duty of a probation officer to investigate any case referred to him for investigation by the court in which he is serving and report thereon to the court."

More and more courts are requesting presentence investigations on all offenders, first as a means of determining fitness for probation and second as a means of arriving at suitable confinement periods. Furthermore, institutional classification personnel need such reports to assist them in properly treating committed offenders. Rule 32 of the Federal Rules of Criminal Procedure stipulates that "The probation service of the court shall make a presentence investigation and report to the court before the imposition of sentence or the granting of probation, *unless* the court otherwise directs. The report shall not be submitted to the court or its contents disclosed to anyone unless the defendant has pleaded guilty or has been found guilty.

"The report of the presentence investigation shall contain any prior criminal record of the defendant and such information about his characteristics, his financial condition and the circumstances affecting his behavior as may be helpful in imposing sentence or in granting probation or in the correctional treatment of the defendant, and such other information as may be required by the Court." (5)

The Manual of the Federal Probation Service sets forth the following purpose of the presentence investigation "The presentence investigation aims at proving neither the guilt nor innocence of the defendant. Its primary object is to focus light on the character and personality of the defendant, to offer insight into his personality needs, to discover those factors underlying the *specific offense and his conduct in general* and to aid the court in deciding whether probation or some other form of treatment is for the best interests of both the offender and society." Not only is the presentence report of value to the sentencing judge, but it becomes a valuable document in the hands of the probation officer with

reference to future treatment should the defendant be awarded probation. Likewise the report becomes a basic document for institutional classification personnel as they evaluate and assign an offender who may be committed to prison.

As to the actual content of the presentence report there is no one system of organization that is necessarily better than another. However, for purposes of utility the federal courts have developed a fairly standard routine for the preparation of a presentence investigation.

At the outset of the report a summary of the basic facts of the offense is presented. This material is taken from the files of the United States Attorney, from interviews with investigative agents who were assigned to the original investigation, and usually contains a statement also given by the defendant. One reason for preparing this review is due to the fact that in cases which are not contested in the courts, only the bare facts may come to the attention of the judge. Frequently there is additional relevant information surrounding the basic facts of the crime which will prove significant to the court.

Immediately after an offender is referred to the probation office for a presentence investigation, a well-defined procedure leading to a comprehensive field investigation is instituted. This investigation begins with a lengthy interview of the offender. At this point a good deal can be learned about the individual's attitudes and something about his personality and general social background. Preliminary inquiry into any prior record of delinquency or criminality is made. Information about his early life, his family background, educational attainment, employment history, marital status, military experience, physical condition, and leisure time pursuits is assembled.

Subsequently, basic facts gained at this time are verified through official inquiries including fingerprint clearances with the F.B.I., the Chicago Bureau of Criminal Information, Bureau of Criminal Identification, the Sheriff's office or other law enforcement agencies.

Verification of school records and the entire employment history is secured. Not only is the employment verified but evaluations of employment adjustment are usually sought.

Field interviews with the defendant's most recent employers are held.

Visits to the offender's home are made, correspondence with key persons who have had close association with him is instituted. Verification of military service by correspondence is routinely secured, and summaries of information about an offender from any social agencies, medical clinics or other community services are collected. Frequently during this time several interviews are held with the offender and members of his immediate family. Experience has shown that in the hands of a skilled probation officer the process involved in conducting a presentence becomes both a treatment measure and a source of diagnostic information. At this point in the court proceedings, defendants are anxious to discuss their problems.

Following the traumatic experience of arrest, interrogation, probable incarceration pending trial or bond release, and the actual trial hearing, the probation officer is frequently the first person to whom the defendant can unburden his pent-up fears and emotions. Here the professional skill of the well-trained, experienced probation officer who has learned to function in a highly charged emotional situation without himself becoming emotionally involved will largely control the value of the presentence process as a treatment tool. The beginning of a new kind of relationship is formed during which the probation officer may help the defendant face up to reality and take stock of his potential capacities as well as past error. Subtle attitudes are probed, and as facts are assembled which may or may not jibe with the offender's story, these facts are discussed with the offender, always with the purpose of gaining a clearer understanding of his total personality. Frequently during this process attitudes are sorted out and objectively discussed. Feelings about early home life, school adjustment, marital problems and unemployment situations are observed. As attitudes are reassessed and the realities of life's social demands are jointly reviewed, the defendant may and frequently does begin to acquire some insight into his personal problems. At the conclusion of the presentence investigation period, if handled skillfully, not only will the probation officer have a sound basis for ap-

praising the capacities of the offender for adjustment on probation, but the offender himself will know pretty well the kind of evaluation being presented to the court.

All of this of course takes time. A month should be allotted for such investigations to provide adequate time for full verification of background information including military record, employment adjustment in other communities, etc., and to give the probation officer time to assemble and evaluate the findings. At any given time each officer will of course have a number of such investigations under way.

Upon termination of the field investigation a comprehensive report is filed with the court summarizing the entire findings and concluding with an evaluation and suggested plan. Some courts desire a recommendation but whatever the probation officer's evaluation, the final decision as to sentence rests solely with the judge.

International Developments

To discuss the whole problem of the examination of delinquents in terms of correctional treatment a United Nations seminar was convened in Brussels, Belgium in 1951. The title of the seminar was "The Medico-Psychological and Social Examination of Delinquents." At this seminar some hundred highly qualified experts from 18 different countries representing the fields of law, judicial administration, psychiatry, social work and prison administration participated in the conference. This report is of keen interest as it relates directly to the problem of defining the rule of the expert who applies his knowledge and skill to the assistance of the court in determining the best possible sentence.

The conference was divided up into various sections. The scientific section included psychiatrists, social workers, probation officers and lawyers.

The report of the scientific section is of special significance. Its terms of reference were, broadly, to see what the medical and social sciences have to offer in this field; to examine the value and utility of different scientific methods and techniques in investigating and explaining the personality and conduct of delinquents; and to consider how best the results of these investigations could be brought to bear

in helping the courts to decide on the most appropriate method of treatment. Cognizance was also taken of the value of such information to those charged with applying such treatment most effectively. The report suggested that the social caseworker or probation officer should be used to ascertain the social facts, to assist in interpreting the social data and then participate in the therapeutic after-treatment. This report affirmed that the probation officer can be of great aid to the court in selecting cases for further scientific examination, especially when he collaborates with the medical officer.

Earlier in this paper it was suggested that the probation officer is not subject to cross-examination. However, the privileged nature of presentence reports has not yet been clearly established in all jurisdictions. The confidentiality of such reports is discretionary in the federal courts. In some states such reports must be made available to defense counsel. There are those who believe that due process is not afforded an offender unless the defense has an opportunity to examine the report of the probation officer. Yet, since guilt is not at issue, an equally strong case can be made for protecting the confidentiality of the presentence report. Such reports concern themselves with the delicate matters of family and marital adjustment, with the intimate details of personal experiences, medical, emotional and mental capacities which are recorded and evaluated solely to guide the court in sentencing and to assist those who may later be charged with correctional treatment.

It is interesting to note that the privileged nature of the presentence report was one of the major concerns at the Brussels seminar. The Scientific Section discussed the question of communication to the defense, and particularly of the public discussion of the reports of experts in open court. It was agreed that so long as the court was concerned with questions of guilt and criminal responsibility, any material which would be used by the court must be communicated to the defense. But the situation was considered different when decision as to guilt had been made and the court was deciding only the question of treatment. The court probation officers and social workers of the Section were unanimously of

the opinion that serious disadvantages would result if the reports they made to the court were made public, or even if they were communicated to the offender or to his counsel. The result of such a system would inevitably be that the court would not receive a full report, but only a discreet synthesis of the whole. On the other hand, attention was drawn to the legal rights of the defense, and the difficulties which would be encountered in certain legal systems, particularly where the decision of the court was regarded as one process, and not (as in the Anglo-American system) two processes.

The Section concluded that all the expert reports should contain all the information necessary to enable the court to decide the treatment of the offender with full knowledge of all relevant considerations. The Section also suggested that such reports must necessarily contain matter which should not be revealed to the offender, because it might cause him or his family some personal distress or even prejudice the success of his treatment.

It becomes apparent, therefore, that if the scientific validity of the presentence report as a privileged communication is to become generally accepted, the probation officer, or court social worker, must be a highly trained professional person.

In the federal courts graduate training in social work and the social sciences generally is expected. The delegates to the Brussels seminar concluded that the probation officer-social worker should be carefully selected and professionally trained, with a solid foundation in the social sciences in which casework plays a leading part. And finally, *the issue of his status as an expert witness should be considered,* says the Brussels report.

Conclusions

As one studies the history and development of new techniques and procedures in the administration of criminal justice, one is aware of the slowness with which society accepts major innovations in the administration of criminal law. Considering the conservative history of criminal law, one is quite amazed at the rapidity with which probation has developed

and the extent to which it has been accepted by the community as reflected in the practice of the courts. At times perhaps the institution of probation has advanced more rapidly in its utilization by the courts than the community's acceptance of it. We are well aware that only as a new expert demonstrates his competence, integrity and scientific objectivity, does the community accept his testimony and participation in the court process. As we have seen from the conclusions of the Brussels seminar this is no job for an amateur. The probation officer—social worker if you will—must be a well-trained skilled individual familiar with basic mental hygiene concepts. He must be thoroughly aware of the major tenets of sociology, understand the dynamic elements of psychology, and be cognizant of the findings of cultural anthropology. He must certainly familiarize himself with the broad and growing fund of knowledge about socio-psychological causation of delinquency. Graduate training in social work, particularly where opportunities are provided for supervised field work or "interneships" in well administered probation departments or correctional institutions, can provide such information and develop casework counselling skills.

Recently Sir Basil Henriques, a prominent English jurist, while visiting Chicago, commented that as the courts of England have become more and more concerned with a scientific approach to the treatment of offenders, they have recognized that a key person in the scheme of criminal jurisprudence, insofar as corrective treatment is concerned, is the probation officer. Sir Basil indicated that no probation officers are being appointed to these positions in the English courts who are not fully trained, and, in fact that the British Home Office has undertaken to provide adequate scholarships and fellowships to assure competent professional training for all probation officers considered for such work.

Standards are being raised in many of our own court systems. In 1950 the federal courts, by action of the Judicial Conference of the United States Courts, established the Federal Probation—Training Center in Chicago. This Center operates in conjunction with the University of Chicago and the staff of the federal probation officer in this district. In-

tensive inservice training in probation and parole techniques is carried on at this Center. Elsewhere special training programs are under way and the general educational requirements for probation officers are constantly being raised. The National Probation and Parole Association which is the leading standard setting organization is conducting a nationwide campaign to elevate the practice of probation casework to a high professional plane.

Roscoe Pound, former dean of the Harvard Law School has said that probation is the greatest legal invention of modern times. The continuous success depends upon the care with which offenders are selected for such disposition, and the quality of correctional treatment and supervision subsequently conducted.

As we continue to gain in experience, to set high standards for probation officers, and to demonstrate the validity of probation as a diagnostic and therapeutic crime control measure, acceptance of the probation officer as a special kind of forensic scientist is destined to become widespread.

REFERENCES

1. Durham vs. U. S., Court of Appeals, Washington, D. C., July 1, 1954, 214 F. (2d) 862.
2. *National Conference of Law Observance and Enforcement,* "Report on Probation and Parole," U. S. Govt. Printing Office, 1931.
3. *Federal Probation,* "Probation Is Casework," June 1948, pg. 52.
4. Title 18 U. S. Code Ch. 231.
5. Federal Rules of Criminal Procedure, Rule 32. 1950 Revised Edition.

U. S. Court House
Chicago 4, Illinois

Determination of Nonpaternity by Blood Groups*

A Series of Two Hundred Cases

*Roger W. Marsters, Ph.D.***

The use of blood grouping tests to negate the possibility of paternity has had a qualified acceptance by the courts, especially in this country. For over 300 years the attitude of the courts has reflected the presumption of legitimacy observed under old English law, where this presumption simply could not be rebutted if the husband was within the four seas of England and not suffering from a physical disability. According to Schatkin (1) it was not until 1732 that the courts would even listen to evidence casting doubt on a husband's paternity. It was recognized from earliest times by English law that a married woman may have an illegitimate child, but the purpose of early Elizabethan bastardy statutes was apparently to provide support for all illegitimate children and thereby save the community the expense of their care.

Following the discovery by Landsteiner in 1901 of the two blood agglutinogens A and B, a proposal to explain their inheritance was advanced in 1910 by von Dungern and Hirszfeld. Their theory did not quite fit the observed inheritance patterns, and in 1924 Bernstein postulated the existence of three allelic genes, A, B, and O to account for the inheritance of the agglutinogens A and B. There followed a large number of family studies carried out to corroborate Bernstein's theory. Wiener (2) presents a summary of a combined series of 10,-

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** Department of Pathology, Western Reserve University School of Medicine at City Hospital, Cleveland, Ohio.

628 families with 24,343 children covering the period 1924–1932. There were only 45 apparent exceptions to the accepted theory of inheritance of these blood factors and in not one of these could the possibility of illegitimacy be excluded.

Since that time other blood factors have been discovered and their mode of inheritance carefully studied. At the present time, the certainty of the inheritance of the factors which determine the individuality of the blood is accepted without reservation. Over the past decade there has accumulated a tremendous fund of knowledge concerning the blood groups and blood group antibodies. At the present time there are nine genetically independent blood group systems and the presence or absence of these various blood factors can be delineated among the members of a family by the reactions obtained with the specific antibodies.

In this way the genetic contribution from each parent can be demonstrated in their offspring. Since each of these blood group systems has been shown to segregate independently with each new generation, the number of possible combinations of the blood groups which can and do occur is at least over 100,000.

It is conceivable that an individual's identity could actually be established on the basis of his own particular combination of blood factors. In a group of 250 unrelated individuals tested with a battery of fifteen different antiserums, Sanger and Race (3) found that 53 per cent were unique in their combinations of blood groups. If samples from the same individuals had been resubmitted as unlabeled specimens over one-half could have been identified correctly.

At present, the scarcity of many blood group antiserums and the complexity of the technics involved, restrict the practical application of blood grouping in bastardy cases to ruling out paternity, rather than attempting to establish it. Such tests may possibly exclude an incorrectly accused man, depending on the extent that the individuality of the blood genes is established. Wiener (2) has calculated that an accused man, not the father, can be excluded on the basis of the ABO groups in 18 per cent of the cases, by the M-N groups in 18 per cent and by the Rh-Hr groups in 25 per cent. The use of the S factor in conjunction with the M-N groups increases the chance from 18 to 23 per cent while the use of all of

these systems increases the chance to almost 55 per cent. This combined probability of an exclusion is not the sum of the separate systems listed because simultaneous exclusions in more than one system will occur.

Added evidence of the value of blood group study is the application of blood groups to ethnology. Blood groups possess significant advantages over other methods of anthropometric classification. The laws of their hereditary transmission are well known and they are not modified by external influences.

Methods

With only three exceptions, all of the parties involved in each of these 200 cases had blood specimens taken at the same time and in each other's presence. In this way all individuals concerned observed the taking of the specimens, satisfied themselves as to identities, and listened to a brief description of how the tests were to be performed and interpreted. Emphasis was placed on explaining the reason for the "non-exclusion" type of report where the blood groups were compatible with one another. The two adults also signed their names on the protocol sheet which was used to record the grouping data.

All blood specimens were drawn by the author or his technician in his presence. The individual whose blood was being drawn was asked to check the labels immediately after emptying his blood into the tubes. Tubes were set up in pairs and labeled with gummed paper labels, usually prepared ahead of time, with the following noted in ink: date, name, and the designation "mother," "man" or "child."

Each blood specimen was divided between two tubes. From adults, 5–10 ml. of venous blood was taken from an antecubital vein, while from infants, capillary blood was obtained by stabbing the heel, or thumb in larger infants, with a No. 11 scalpel blade. Usually at least 0.5 ml. could be obtained with some gentle squeezing of the part. Tubes 12 x 75 mm. in size containing a small amount of powdered heparin were employed for infants.

Each set of three bloods, along with known control bloods, was processed independently by the author and his technician through all the steps in the grouping procedures. Each

specimen was grouped for the A, B, C(rh′), D(Rho), E(rh″), c(hr′), M, N, factors. Additional groupings for the e(hr″) factor were done in selected cases and 66 of the cases were grouped for the S factor. Each individual worked with his own specimens and performed all procedures himself. The tests usually were done at different times and there was no sharing of materials or information during the running of the tests. The author maintained a complete set of typing reagents separately for his own use, rotating vials with the technician at intervals between tests. All antiserums employed met N.I.H. standards where these were established, and at least two different makes of most of the antiserums employed were in use at all times. In this way each blood was examined by two different workers usually employing different makes of reagents, or occasionally different lots of the same make. Besides using different makes of anti-D, each individual also performed a duplicate D typing with an anti-D serum of our own preparation. It had been our custom for several years to Rh type all bloods with two preparations of anti-D, one a commercial serum and one of our own preparation, and this practice was continued here. The donor for our own serum was well known to us and her serum was repeatedly shown to contain only D antibodies by us and by an outside laboratory. The indirect antiglobulin test was used by the author for all those D-reactions which were questionably negative.

In general, the technician employed a slide technic for A, B, D, M and N, while the author used tube technics for all tests.

A single exception to the dual source of antiserums was the c(hr′) antiserum employed. This was another serum of our own manufacture and was originally a potent c saline antibody, which gradually lost its saline activity over a period of years and required albumin for its reaction. This serum was obtained from two bleedings of a CDe/CDe (Rh_1Rh_1) mother who had become immunized to the c(hr′) factor through blood transfusion from her husband who was heterozygous CDe/cde (Rh_1rh). This serum did not contain any anti-E antibody.

Recent studies of this c antiserum showed that it apparently did not contain any anti-f antibody. Repeated absorp-

tions with two different examples of cDE/cDE (Rh_2Rh_2) cells indicated that the activity against these cells decreased at the same rate as activity against random Rh negative cells until neither the cells used for absorption nor Rh negative cells gave any reaction. Furthermore, recent bleedings from this patient were found not to contain any anti-f activity by an outside laboratory.

The antigen f, originally reported by Rosenfield, Vogel, Gibbel, Sanger, and Race (4), appears to be related to the Rh-Hr system, since blood cells bearing on at least one chromosome the combination cde or ce are agglutinated by the new antibody. Thus, individuals such as our donor of anti-c, who also presumably lacked the f factor, might also produce anti-f and the possible interference of such admixture in the use of random anti-c serum in paternity work must be evaluated.

In all except one case which involved a man in Service, the blood specimens from each of these 200 cases have been processed at the same time. In this one case the man's specimen was processed by itself but with the same set of reagents as were used for the other blood specimens in the case. By using different preparations of the same antiserums for duplicate tests and by processing all blood specimens together, it was felt that possible interference due to incomplete specificity in any serum would be fairly well eliminated.

Blood Group Genetics

Some knowledge of genetics is necessary to understand the significance of a blood group exclusion. The units of inheritance are believed to be genes which are discrete entities and arranged in a linear order along the chromosomes.

Each individual possesses 24 pairs of chromosomes, and at conception the sex cells, spermatozoa and ova, each contribute 24 single chromosomes so that the offspring again has 24 pairs, half of which represent the contribution from each parent.

Genes occupying the same position or locus on a particular pair of chromosomes may be identical, in which case the individual is termed homozygous; or the genes may be different and the individual is termed heterozygous.

Genes which are different, but alternatively present at the same locus, are called allelomorphic genes. It is believed that only two allelomorphs of one gene can coexist in one individual. The M and N blood factors are allelomorphic genes and three different combinations are recognized, i. e., M, N, and heterozygous MN.

The designations M and N are also called a phenotype because the presence of the M or N antigens can be directly distinguished by the reactions with anti-M and anti-N serums. The aggregate of genes from both maternal and paternal parents represents the genotype. Thus, a phenotype M individual lacks N and is presumed to have a genotype MM. Likewise, an N individual has genotype NN, while an MN individual has the same genotype as phenotype.

Thus, the phenotype represents the first order of discrimination in working out the gene content of an individual, while the genotype often can only be determined by an examination of the individual's parents, or offspring, or both.

At present in the International OAB system all individuals who lack both A and B are arbitrarily classed as type O individuals. Since the O allelomorph does not react with either antiserum for A or B, the heterozygotes AO and BO cannot be differentiated from AA or BB individuals. Thus, genotype AO and genotype AA individuals will type as "A," and this, then, is the phenotype for these two groups. However, AO persons may have an O parent or offspring, while the AA individuals could not have an O parent or offspring.

As the result of the work of Landsteiner, Wiener and Levine some fifteen years ago, the Rh blood system was discovered. Much subsequent work has shown this blood group system to be a complicated but very useful system for resolving problems of identity and disputed parentage.

The Rh-Hr system is composed of six related factors which have been designated by Fisher and Race (5) C-c, D-d, E-e and by Wiener (6) rh′-hr′, Rh_o-Hr_o, and rh″-hr″. There are two different conceptions of the structure of the Rh genes. According to Wiener the Rh system is composed of eight allelomorphic genes, while Fisher and Race believe that there are three pairs of allelomorphic genes which are closely linked. Regardless of which theory is correct, the inheritance patterns are the same and fit both concepts. The eight basic

chromosomes are functionally the same whether a single gene determines three factors or one factor. Each individual carries a pair of these chromosomes which constitutes his genotype.

Antiserums which recognize four of these Rh-Hr factors C(rh′), D(Rh_0), E(rh″) and c(hr′) are generally available but antiserum for the e(hr″) factor is scarce and that for the d(Hr_0) is unavailable. Indeed, Wiener does not believe that the existence of the d(Hr_0) factor has been definitely established.

According to Fisher and Race each chromosomal pair carrying the Rh-Hr factors will possess either CC, cc, or Cc with the same three possibilities in the remaining D-d and E-e systems. Thus, the number of genotype combinations is at least 78, while by the use of five Rh-Hr antiserums—anti-C, D, E, c and e, a total of only eighteen phenotype groups can be differentiated. Therefore, each particular combination of reactions with these five antiserums will indicate a probable genotype, with the understanding that other less common genotypes may be present to yield the same reactions.

Usually the errors involved in selecting the "most probable genotype" are in the order of 5 to 10 per cent. However, the application of such practice to Negro bloods results in significant discrepancies. Thus, in this paper we have adopted the suggestion of Mourant wherein the letter designations are employed as phenotypes. Genotypes are presented only where they appear to be well established.

Therefore, Rh positive individuals are represented as D and Rh negatives as d. On the other hand, both antiserums for C and c were routinely employed in this series and the two possible genotypes for phenotype C(CC and Cc) could be differentiated since the heterozygote yields positive reactions with antiserum for c. In the same way, most of the E-positive bloods in this series have been tested with anti-e so that the two E-positive genotypes (EE and Ee) have been differentiated.

In submitting reports of blood grouping results in paternity cases, it is simpler to report the reactions for each person as "positive" or "negative" with each antiserum in the form of a table. The use of alphabet letter designations for the Rh-Hr factors is consistent with their use for blood factors

generally and, when phenotypes are used in medico-legal reports, the Fisher-Race system has the advantage that no new designations are introduced and the lines of inheritance can be followed more clearly by the uninitiated. In practice, however, most workers in the field use some combination of both systems.

Results

The individuals were classified as either white or Negro at the time the blood specimens were taken, on the basis of skin color and facial characteristics. The majority of the whites were American by birth, although there were a few foreign born individuals of European extraction. The single Oriental in the series was listed in the white group. There were 226 white adults and 174 Negro adults involved in the 200 cases and the distribution of the blood groups found is presented in the tables.

TABLE 1

BLOOD GROUP DISTRIBUTIONS FOUND AMONG 226 WHITES AND 174 NEGROES

OAB BLOOD GROUPS

	WHITES		NEGROES	
Group	Number	Per Cent	Number	Per Cent
O	102	45	97	56
A	88	39	43	25
B	24	11	27	15
AB	12	5	7	4

M-N BLOOD GROUPS

	WHITES		NEGROES	
Group	Number	Per Cent	Number	Per Cent
M	83	37	33	19
N	35	15	39	22
MN	108	48	102	59

S-s BLOOD GROUPS

	88 WHITES		44 NEGROES	
Group	Number	Per Cent	Number	Per Cent
S	46	52	20	45
s	42	48	24	55

TABLE 2

Rh-Hr GROUPS

Phenotype	226 WHITES		174 NEGROES	
	Number	Per Cent	Number	Per Cent
cde or rh	33	14.6	11	6.3
CcDee or Rh_1rh	73	32.2	40	23.0
ccDEe or Rh_2	32	14.2	27	15.5
ccDee or Rh_O	5	2.2	84	48.3
CcDEe or Rh_Z	34	15.0	10	5.7
Ceddee or rh'rh	2	0.9	1	0.6
ccddEe or rh"rh	1	0.5	—	—
CCDee or Rh_1Rh_1	45	19.9	1	0.6
CCDEe Rh_1Rh_Z	1	0.5	—	—

Although the total number of individuals tested is small, the percentages of the various blood groups found among the white individuals are in line with the accepted frequencies, while the data for the Negro individuals reflect the higher incidence of the B factor and lower incidence of the M and S factors found in this race.

The Rh-Hr frequencies observed show the lower incidence of Rh negatives among the Negro (6.3 per cent) as compared to whites (14.6 per cent) and the common occurrence of the "pure D" or Rh_O combination in this race.

Of 174 Negroes the phenotype Rh_O was demonstrated 84 times (48.3 per cent), while among 226 whites this phenotype was seen in only five individuals (2.2 per cent). Only 9 of the 18 possible phenotypes are presented in the table since no examples of the other possibilities were observed.

In the entire series of 200 cases involving 217 children there were no discrepant mother-child inheritance patterns, while there were 33 discrepancies between the purported father and the child, including one divorce case where two children were excluded. These inconsistent man-child relationships were either in one, two or even three separate blood group systems. There were 20 exclusions involving whites, and 12 exclusions involving Negroes.

There was a total of fifteen single exclusions where a factor was found in the infant but not found in either adult including six in the OAB system, four in the M-N, four in the Rh-Hr system, and one in the S system. In addition there were four double exclusions in two different blood group systems of this class. There were nine exclusions based on the failure

to find an expected factor in the child including one in the OAB system, five in the M-N, and three in the Rh-Hr system involving C-c (rh'hr'). In addition there were four double exclusions with a combined lack of a certain factor and presence of some other "new" factor. A summary of all exclusions found is presented below.

TABLE 3

SUMMARY OF 32 BLOOD GROUP EXCLUSIONS

Case No.	Color	Mother	Man	Infant	Exclusion
4	W	O, MN, cde	O, MN, ccDEe	O, M, CcDee	Presence of C
8	W	A, M, ccDEe	O, M, CCDee	A, MN, CcDEe	Presence of N
17	N	A, N, ccDee	B, M, ccDEe	O, N, ccDee	Lack of M
18	N	A, MN, CcDee	A, N, CcDe	A, M, ccDee	Lack of N
				A, M, CcDee	Lack of N
				A, MN, CcDee	———
19	W	O, MN, CcDee	O, MN, CCDee	O, MN, cde	Lack of C
45	W	O, N, ccDEe	O, N, ccDEe	A, MN, ccDEe	Presence of A & M
50	W	O, M, CCDee	O, M, ccDEe	O, M, CCDee	Lack of c
52	W	B, MN, cde	O, MN, CcDee	AB, MN, CcDee	Presence of A
54	N	O, M, CcDee	O, M, cde	O, MN, CcDee	Presence of N
58	W	O, M, CCDee	O, MN, ccDEe	A, M, CcDee	Presence of A
62	W	O, MN, cde	A, MN, CCDee	B, N, CcDee	Presence of B
64	N	O, M, ccDee	A, MN, ccDee	A, MN, ccDee	———
				O, MN, CcDee	Presence of C
74	W	O, MN, CcDee	O, N, CCDee	O, N, ccDEe	Presence of E and lack of C
75	W	AB, M, CcDEe	O, M, ccDee	A, M, ccDEe	———
		Second man:	O, MN, CCDee		Lack of C
88	N	B, MN, cde	O, MN, ccDee	A, M, ccDee	Presence of A
90	N	A, MN, ccDee	A, MN, cde	O, N, ccDEe	Presence of E
102	W	O, M, CCDee	O, M, ccDEe	A, M, CcDee	Presence of A
104	W	B, M, cde	AB, M, CCDee	B, MN, CcDee	Presence of N
105	N	B, MN, ccDee	O, MN, ccDee	AB, MN, CcDee	Presence of A & C
122	W	O, MS, CcDee	O, Ms, CcDee	O, MS, CcDEe	Presence of E
124	W	A, MNs, CCDee	O, NS, CcDee	O, MS, CcDee	Lack of N
131	N	AB, Ms, ccDee	O, MNs, ccDee	B, MS, ccDEe	Presence of S & E
133	W	A, Ns, CCDee	AB, Ms, cde	A, MNS, CCDee	Presence of S and lack of c
135	W	B, Ns, CcDee	O, MS, cde	A, MNS, CCDee	Presence of A and lack of c
138	N	B, Ms, ccDee	O, MNs,cde	AB, Ms, ccDee	Presence of A
150	W	O, Ms, ccDEe	A, NS, CcDee	O, Ms, CcDee	Lack of N
152	W	B, Ms, CcDee	A, Ns, CcDee	O, MS, ccDEe	Presence of E & S and lack of N
161	W	O, MNs, CcDEe	AB, Ms, cde	O, Ms, CcDEe	Lack of A or B
167	N	B, MNs, ccDee	B, MNs, cde	B, MNS, CcDee	Presence of S & C
169	N	O, Ms, ccDEe	O, Ms, ccDee	O, MS, ccDEe	Presence of S
176	W	A, MS, CcDee	AB, Ns, CcDee	A, MS, cde	Lack of N
179	N	O, M, ccDee	O, M, CcDEe	O, MN, CcDee	Presence of N
				O, M, ccDEe	———
				O, M, CcDee	———
				O, M, CcDee	———
				O, M, CcDee	———
				O, M, CcDee	———

Among the defendants who requested blood tests, the results proved that the plaintiffs had named the wrong man in a significant number of cases. In this series of 200 there were 32 exclusions which can be assumed to represent only approximately half the actual number since that proportion of men cannot be excluded because of chance similarity of blood groups. Thus, one out of every three men who requested blood tests was innocent of the paternity charge.

Cases Grouped for the S Factor

The designation S refers to a new blood factor discovered in 1947 by Walsh and Montgomery (7). The antibody detecting this new blood antigen was originally found in the serum of a mother who delivered a macerated, stillborn infant. The new agglutinogen was related to the M-N system because a significantly higher proportion of type M bloods were also S-positive.

Studies of the inheritance of this new factor have been made but there appear to have been no published reports of the application of S in paternity cases. The A.M.A. Committee on Medico-Legal Problems (8) does not yet recognize such application of the S factor. Antiserum for S is scarce and we had only sufficient quantity for 66 cases.

The S with its allelomorph s probably represents a separate pair of genes closely linked on the M-N chromosome. All bloods tested so far which were S-negative have been found to be s-positive, proving the alternative nature of these factors.

Since anti-s was not available for this study, the anti-S would class both heterozygous and homozygous bloods Ss, and SS, together as S-positive. Thus, exclusions could only be established on the negative-negative-positive result for mother-man-child. No "failure to inherit" exclusions could be established, since without anti-s, homozygous SS could not be established.

From published studies of over four hundred families it has been apparent that the mating of S-negative parents can only produce S-negative offspring as would be expected. Allen (9) presented additional data with 32 S-negative matings and 78 offspring, all S-negative.

There have been fewer family studies on MNS inheritance in Negroes, but Neel and Hanig (10) showed that of 41 children of S-negative parents all were S-negative.

In the 66 cases in this series grouped for S, there were five where the adults were S-negative and the child in question S-positive. In one case there was a triple exclusion including both the Rh-Hr and M-N systems, in three cases there were double exclusions including additional exclusions in the Rh-Hr system and in one case (Case No. 169) the S exclusion was by itself. Thus, four out of five S exclusions were confirmed by simultaneous exclusions in other systems. The case with the S exclusion alone was completely redone with new specimens before a report was made. In addition, the Ortho Research Foundation confirmed these results with three different specimens of anti-S. The complainant after some hesitation asked that the charge against the man be dismissed.

As antiserums for some of these newly discovered blood factors become available, they will be applied to paternity studies. Statistically, the addition of anti-S to the M-N system increases the efficiency of excluding an incorrectly accused man from 18 to 23 per cent; when anti-s becomes available the chance will go to over 27 per cent, so that the MNSs system will be more efficient than the Rh-Hr.

Significance of the Result

The establishment of an exclusion is most simply consummated by the demonstration of some blood factor in the child which is foreign to either the blood of the mother or the putative father. Thus, with a certain serum, and it can be of any specificity, the blood cells of the mother and man react negatively, while the red blood cells of the child react positively. This kind of exclusion is clear-cut and readily understood. Examples are presented below.

Exclusions on Basis of Strange Factor in Child

	Anti-A	Int.	Anti-M	M-N	Anti-C	Rh-Hr	Anti-S	S-s
Mother	Neg.	0	Neg.	N	Neg.	c	Neg.	s
Man	Neg.	0	Neg.	N	Neg.	c	Neg.	s
Child	Pos.	A	Pos.	MN	Pos.	Cc	Pos.	Ss

A second class of exclusions is the "failure to inherit" or lack of a certain factor in the child and involves more understanding of genetics than the first group. This second type applies only in those cases where the complete genotype can be established such as for type AB, MM, NN, or Rh_1Rh_1 or Rh negative (cde or rh) individuals. Type AB individuals must contribute either the A or B to each offspring. Likewise, a type M individual (with the genotype MM) must pass along an M to each offspring. In other words, a type M individual can only conceive type M, or type MN offspring. A type N child would exclude because it lacks the M factor. In the same way an N man would be excluded by a type M child. In the Rh-Hr system an Rh negative individual can only conceive other Rh negative or heterozygous Rh positive offspring. A child homozygous Rh positive will exclude. In the same way a homozygous positive man would be excluded by an Rh negative (homozygous cc or hr′/hr′) child. Examples of this second type are presented below.

Exclusions on Basis of Failure to Inherit

	Int.	M & N	Rh-Hr	Rh-Hr
Mother	O	MM	cc or rhrh	CC or rh′rh′
Man	AB	NN	CC or rh′rh′	cc or rhrh
Child	O	MM	cc or rhrh	CC or rh′rh′

Blood grouping in cases of disputed paternity can only be uniformly useful when an exclusion is found. Serological evidence of nonpaternity represents impersonal, objective, factual evidence which can be rechecked and corroborated by any other qualified worker as long as the individuals concerned are still alive. The defendant's right to request that blood tests be performed should discourage many accusations of paternity known by the plaintiff to be false.

In each of the 32 exclusions presented here the discrepant inheritance pattern always involved the putative father and never the mother. This is good evidence in itself that the genetics of blood group inheritance is firmly established, since if other causes were operating then as many inheritance discrepancies would involve the maternal parent as the paternal parent. Because the type of case which predominates in this

series was the unmarried mother seeking financial support for her child, it is not probable that one of these women would "borrow" a baby simply to bring charges against a man.

Perhaps the most convincing evidence of the value of blood grouping determinations in disputed paternity is the woman's reaction to the adverse report. Out of the 32 cases where exclusions were found, the plaintiff simply dropped the charges against the man in all but three cases. While many of the mothers never admitted relations with another man, their change of attitude was impressive and their decision not to carry the case to trial was considered tacit admittance of the correctness of the exclusion. Only three of the exclusion cases ever came to trial over the five-year period and in two of them the decision was favorable to the defendant.

The one case found for the mother was a double exclusion on the S and Rh-Hr systems where the Rh-Hr exclusion had been independently confirmed by a qualified worker. Plaintiff's attorney argued vigorously before the jury that since only two factors out of all the known blood factors excluded, while the rest "included," that therefore the weight of evidence showed he was the father. This decision by the lower court has recently been reversed by an appeals court.

This similarity between the blood groups of putative father and infant must not be considered in a positive interpretation because any other man with the same blood group combination could also be the father. Thus, a nonexclusion report should never be admitted in evidence since it might prejudice a jury. Because of this a woman who knows the man she has named is truly the father of her child need have no fear of the results of the tests. If she hesitates to appear for the blood test this can cause her case to be indefinitely postponed or evidence of such refusal may be introduced against her in court.

In the same way there are always inconclusive results on certain blood groups where there is an exclusion on one system. Any baby will resemble the accused and all other men, including its true father, in many respects. Such similarities are not significant. About 40 per cent of incorrectly accused men will have the same or similar blood groups as the child and therefore cannot be excluded. It is the dissimilarities

which are important. Thus, an exclusion based on two or perhaps three different blood groups is no more significant than an exclusion on a single factor.

Occasionally some uncommon combination of Rh-Hr factors is observed in the putative father and also the child and here there is some basis for presuming a connection. For example, in Case No. 69, the husband in a divorce action was shown to possess the uncommon Rh-Hr combination cdE/cde or rh″rh as did the child in dispute. The mother, who was CDe/cde or Rh_1rh, would be approximately 100 times as apt to obtain this particular combination from her husband as from some other man.

When the unusual nature of the blood group combination present both in his blood and that of the child was explained to him, this man readily admitted paternity and the case was settled out of court. In another similar case (No. 72) where the uncommon grouping Cde/cde or rh′rh was found in both the accused and the child, the man changed his plea to "guilty" when the circumstances were explained to him.

The importance of properly identifying all parties concerned, especially the putative father, at the time the bloods are taken cannot be overemphasized. We have utilized face-to-face identification because it is quick and final and it is inconceivable that the woman would fail to properly identify the man from whom she is seeking financial support for her child. Furthermore, in the majority of cases reported here, the adults have been unmarried and the only issues were maternity costs and support for the juvenile.

In many cases the man and woman seemed entirely congenial and often arrived and left together. It appears that the problem has been taken to court mainly to formalize the obligation for support and to fix the exact amount to be provided by the man. Other cases would apparently not be brought into court except for the pressure exerted by the welfare agencies to transfer the financial responsibility for the child from public funds to the natural father.

A recent case emphasizes the importance of securing proper identification of the man. After submitting a nonexclusion report it was revealed by the Court that this particular case was being retested at the request of the mother. She

claimed that the proper man must not have appeared for the first test and even volunteered to pay for the second test. It developed that she had not been given the opportunity to identify the man at the time the first tests were taken.

A later comparison by the court of the two reports showed identical results for the mother and child, but in the first instance the man was a type AB, MN, D-positive individual and in the second instance the "same man" was a type B, N, D-negative. An exclusion had been established on the basis of the first tests, but because of the strong objections of the woman the court had agreed to authorizing a second test. The defendant was not excluded on the latter results. Obviously some other man had presented himself instead of the defendant when the original test was performed.

It is wise to use the term "incorrectly accused" as suggested by Schatkin (1) since in many of these cases the woman is promiscuous and cannot know who the true father is. Sometimes such a woman, after finding herself pregnant, has apparently had relations deliberately with the man of her current choice and then later announced to him her condition. In the majority of bastardy cases, however, the woman knows who the true father is.

In one such case a friend of the accused also appeared at the time of the appointment insisting he was the father of the child in question. Although he was not legally involved, he refused to be ignored and a blood specimen was finally taken from him as well as from the accused. The results of the tests excluded him but the defendant was not excluded. The mother had apparently named the true father.

Out of 859 paternity cases filed in Cuyahoga County (Cleveland) for the year 1955 (11), only 67 defendants requested blood tests. The great majority of men accused of paternity pleaded guilty to the charge, many of them at the first hearing. On the other hand, the putative fathers who do request blood tests must be a select group because the percentage of exclusions is high in these cases. Of these 67 men, 8 (12 per cent) were excluded. Among the entire series of 200 cases reported here the percentage is higher (16 per cent), doubtless due to the inclusion of some divorce cases. The fact

that the man usually has to pay for the blood examination acts as a deterrent to the frequent running of the tests.

In conclusion it can be stated that the unchallenged testimony to a blood group exclusion submitted by a qualified worker must be accepted by the Court. An exclusion of paternity based on the blood groups represents a fact of science and is not simply an "opinion" of the expert.

That the courts, and especially juries, do not always recognize the significance of a blood test exclusion is disconcerting. It must be admitted that the man and woman have usually had relations and in many cases neither knows who the real father is. Many times if the man accused is not the true father it is merely a stroke of fate that he is not. Furthermore, the law considers marriage as a contract with certain obligations. However, in spite of the fact that occasionally a blood group exclusion will create a community problem by throwing a woman's case out of court, no man can be expected to support a child not his own.

The blood grouping tests which result in a nonexclusion also serve a useful purpose. Many times a guilty plea was entered by the defendant when the tests failed to exclude him as the possible father. In such cases the blood test helped to resolve the lingering doubt which is so frequently in the mind of the accused.

Accuracy of the Result

The question of the accuracy of the blood grouping results is occasionally raised. There are two possibilities of error, either that an exclusion would be overlooked and a nonexclusion report submitted or that an exclusion itself would be in error.

With regard to the first possibility, i. e., that an exclusion would be missed in the first instance, this appears to be a remote possibility. In this series all 200 cases were set up independently by two different workers and discrepancies between the two sets of data occurred only rarely and never involved an exclusion of a putative father. Each of the 32 exclusions was found independently by the two workers and would have therefore not been missed by either individual working alone.

There were approximately ten discrepancies in the two sets of data when formally compared. These discrepancies were in the M–N system, the S or the C and E reactions. There were no discrepancies noted in the A, B, D(Rh_O) or c(hr′) reactions, nor were there any discrepancies noted between the serum and cell reactions in the International OAB system.

These ten discrepancies were among all the reactions performed. Each worker employed between eight and ten different antiserums and there were no less than three different blood specimens for each case. Known control bloods were always included and a few cases involved up to five children. Therefore, each worker performed almost 40 agglutination reactions on each of the 200 cases. The rare occurrence of discrepancies among this great number of reactions demonstrates the high degree of precision and accuracy which is possible with these technics.

Two of the discrepancies were for the C factor and involved weakly reacting C-positive bloods, which were read differently by the two workers. Both of these cases involved Negroes. The occurrence of such variants to the C factor, especially in Negroes, has been observed by Wiener (12) and also Sussman (13). It must be kept in mind that the inclusion of known positive bloods may not guarantee the interpretation simply because the unknown positive bloods will not always react as strongly as the controls.

There were several discrepancies involving the S reactions in spite of the setting up of known S-positive and S-negative control cells by each worker with each batch of unknowns. These can be attributed to the small quantity of this particular serum available and the attendant difficulties. It should be emphasized that the discrepancies which occurred did not involve whether or not an exclusion would be established and they all were found among the "nonexclusion" cases where the report could not be used in evidence.

This is not to minimize the significance of these observations but rather to show that in spite of the painstaking care with which these specimens were grouped by the two workers that an occasional duplicate result was inconsistent. Thus, a rare discrepancy may occur when the final result will be inconclusive either way.

The second possibility that an exclusion, once found, could be in error, is difficult to conceive because in each of the 32 exclusions found in this series the particular reactions were again set up and read at least once, and often several times. That an exclusion could be first observed and then deliberately checked, using fresh cell suspensions and redoing all procedures, and still be in error is such a remote possibility as to be almost incalculable.

The performance of accurate M-N typing seems to be more difficult than Rh-Hr subgrouping. The reactions produced by some anti-M and anti-N serums are transient and more or less reversible so that experience is needed to interpret the reactions. Particularly difficult is the detection of the N receptor in type MN bloods. This must be kept in mind where an exclusion seems to be established by the finding of an N man with a type M child or vice versa. In all such cases encountered the M-N tests were repeated several times with additional antiserums to confirm the original observations.

In addition, there have been reports of the rare occurrence of weakly reacting subgroups of N, designated N_2. In Denmark, eight such bloods were observed among approximately 80,000 medico-legal blood group determinations. Four of these cases were found on ordinary routine examination of the specimens. These weakly reacting N_2 bloods therefore occur so infrequently as to be of little practical significance. In the cases in this series where the possible occurrence of the N_2 receptor might have influenced the interpretation the technic recommended by Andresen (14) was employed. This technic essentially consists of carefully comparing the rates of reaction between room temperature and 4° C. under which conditions the N_2 receptor will give satisfactory reactions.

The age of the infant has not appeared to influence the avidity or strength of the grouping reactions. Routinely, cases are scheduled only after the infants have reached the age of one month, but tests have been performed on offspring ranging in age from one week up to the age of fifteen years. Therefore, the possibility of "false negative" reactions due to so-called immaturity of the erythrocytes would not seem to be of any significance. Most of the blood group antigens

known have been shown to be well developed at birth and in some cases in the fetus even prior to the time of viability.

The possibility that a gene mutation may have occurred to bring about an apparent exclusion has occasionally been suggested. The incidence of such mutations is not known accurately, since their occurrence is so infrequent. A figure of 1 in 50,000 is estimated for human gene mutations. Wiener has aptly pointed out that since such mutations are never observed in careful family studies, there seems little justification for presuming such an occurrence to explain an exclusion. Furthermore, such spontaneous gene changes should thus exclude the maternal parent as often as the paternal parent.

It is the extensive mother-child experience which demonstrates the reliability of blood group inheritance patterns. In Denmark where all blood groupings in paternity cases are performed in a central laboratory, only one case of a probable mutation within the M-N system has been observed in a series of 60,000 mother-child combinations.

A few examples of unusual Rh-Hr combinations have been reported which can perhaps be considered as mutations. Race, Sanger, and Selwyn (15) reported a so-called gene deletion -D-/-D- case where both C-c and E-e factors were lacking. This individual's serum contained a mixture of antibodies and agglutinated all of 1,400 erythrocyte samples but had no effect on her own blood cells. Wiener, Gordon and Cohen (12) reported an individual who lacked both E-e but possessed D and c. Such profound gene changes as these cases represent are so rare than an accurate probability of their recurrence cannot be expressed numerically.

Nor can the possibility of crossing-over of the chromosomes be accorded any significance because in the majority of cases crossing-over would not interfere with the interpretation since no new factors could be so produced. No such instance has been observed in many hundreds of family studies on the inheritance of the Rh-Hr and MNSs factors where crossovers have been particularly searched for and would be readily recognized.

Finally, it can be said that if anyone doubts the validity of the report, then the results should be checked by some other qualified worker. It is recognized that the opportunity to

check any blood grouping result is always present. Each blood grouping specialist who values his reputation is painfully aware of this and as a consequence a report submitted by a recognized worker in the field can be accepted as completely accurate.

Twins

Two cases involving twins are of interest. Twins may be either monozygotic or dizygotic, i. e., one egg or two egg twins. If one egg, there will be only one set of membranes and the two individuals will be essentially doubles of each other. They would, of course, have identical blood groups. Two egg twins come from the fertilization of eggs ovulated more or less simultaneously. Such twins are called fraternal and are no more like each other than ordinary siblings.

In one case a pair of fraternal twins, boy and girl, was tested and the accused excluded on the basis of one twin but not the other.

In a recent case (not included in this series) twin girls were type A and type B proving that they were fraternal twins. The accused was type O, as was the mother, so that he was excluded on the basis of both twins. The possibility was considered in both of these cases that each twin had been fathered by a different man as a result of two separate coital acts close to the time when the two ova were shed. Such a phenomenon is called superfecundation and it is seemingly recognized by animal breeders. There have apparently been no recorded instances of superfecundation in man. A more probable explanation is that one man fathered both twins in each case and excluded the accused on the basis of only one set of genes in the first case, but on the basis of both sets of genes in the second. The pertinent blood groups in these two cases are summarized in the following table:

	First Case	Second Case
Mother	ccDee (Rh_O)	O
Man	ccDee (Rh_O)	O
First twin	ccDee (Rh_O)	A
Second twin	CcDee (Rh_1)	B
Presumed natural father	CDe/cDe (Rh_1Rh_O)	AB

In both of these twin cases the court decided the husband was not the father of either twin in each of these cases.

Conclusions

A series of 200 cases of disputed paternity has been analyzed for the blood factors A, B, C, D, E, c, M, N, and for the e (where there was an E-positive reaction).

The methods employed for taking the specimens, performance of the tests and recording of the results have been presented along with a discussion of the accuracy and significance of the blood grouping results.

There have been 32 cases which resulted in exclusions of paternity. In 29 cases the paternity charge was withdrawn by the mother following submission of the blood grouping report. In the remaining three cases the trial court found for the man in two instances and in the third case following an appeal.

In addition 66 of the cases have been tested for the S factor where a total of five exclusions have been found including one on the S factor alone. All of these S factor exclusions resulted in dismissal of the paternity charge.

Acknowledgment: The technical assistance of Miss Helen Karlovec (cases through No. 167) and Mrs. Lois Wise for the remaining cases is gratefully acknowledged.

REFERENCES

1. Schatkin, S. B.: Disputed Paternity Proceedings. Matthew Bender and Co., New York, 1953.
2. Wiener, A. S.: Blood Groups and Transfusion. Charles C. Thomas, Springfield, Ill., 1946.
3. Sanger, R. and Race, R. R.: The Combination of Blood Groups in a Sample of 250 People. Ann. Eugen. 15:77–90, 1949.
4. Rosenfield, R., Vogel, P., Gibbel, N., Sanger, R. and Race, R. R.: A "New" Rh Antibody, Anti-f. Brit. M. J. 1:975, 1953.
5. Race, R. R. and Sanger, R.: Blood Groups in Man. Charles C. Thomas, Springfield, Ill., 1954.
6. Wiener, A. S.: Medicolegal Aspects of the Rh-Hr Blood Types. Bull. N. Y. Acad. Med. 25:255–260, 1949.
7. Walsh, R. J. and Montgomery, C.: A New Human Isoagglutinin Subdividing the MN Blood Groups. Nature 160:504–505, 1947.
8. Davidsohn, I., Levine, P. and Wiener, A. S.: Medicolegal Application of Blood Grouping Tests: A Report of the Committee on Medicolegal Problems. A. M. A. 1952.

9. Allen, F. H., Jr.: Heredity of Factors S and Kell. Paper presented before American Academy of Forensic Sciences, Sixth Annual Meeting, February, 1954.
10. Neel, J. V. and Hanig, M. M.: The Inheritance and Frequency of the MNS Factors in the American Negro. Genetics, 36:84–92, 1951.
11. Annual Report for 1955, Juvenile Court of Cuyahoga County, Cleveland, Ohio.
12. Wiener, A. S., Gordon, E. B. and Cohen, L.: A New Rare Rhesus Agglutinogen. Am. J. Human Genetics, 4:363–372, 1952.
13. Sussman, L. N.: Blood Grouping Tests in Disputed Paternity Proceedings. J. A. M. A. 155:1143–1145, 1954.
14. Andresen, P. H.: The Human Blood Groups Utilized in Disputed Paternity Cases and Criminal Proceedings. Charles C. Thomas, Springfield, Ill., 1952.
15. Race, R. R., Sanger, R. and Selwyn, J. G.: A Probable Deletion in a Human Rh Chromosome. Nature 166:520, 1950.

Department of Pathology
Cleveland City Hospital
3395 Scranton Road
Cleveland 9, Ohio

QUESTIONED DOCUMENT SECTION MEETINGS
ANNUAL MEETING—AMERICAN ACADEMY OF FORENSIC SCIENCES
DRAKE HOTEL, CHICAGO, ILLINOIS

Friday A.M.—March 1, 1957

Chairman ..... David J. Purtell

Business Meeting

Scientific Papers:

Proportional Spacing Typewriters.....Ordway Hilton

Chromatography.....Donald B. Doud

Differentiation of Typewriting Impressions
Linton Godown

Recent Developments in the Use of Infrared Image Converters.....Richard J. Kuhn

Survey of Office Duplicating Processes.James P. Kelley

Saturday A.M.—March 2, 1957

Chairman.....David J. Purtell

Special Papers on Forgeries. Moderators { Clark Sellers / Ordway Hilton }

A somewhat unusual case.....Albert D. Osborn

The case of the multiple forgeries...Harry M. Ashton

An unusual forgery case.....C. D. Brooks

Interesting forgery problem.....Francis Murphy

The Determination of Volatile Substances by Microdiffusion Analysis*

Milton Feldstein, Ph.D., and Niels C. Klendshoj, M.D., Buffalo, New York

The first step in a general scheme of toxicological analysis of biological material is the separation of volatile poisons. Distillation, the standard method of separation, is time consuming, and involves the use of special apparatus and techniques. This process frequently produces excessive foaming and portions of the material may be carried over into the receiving container, necessitating a second distillation. In addition, steam distillation results in considerable dilution of the volatile materials, thus making more difficult the detection of small quantities of unknown substances.

The use of the standard Conway microdiffusion cell and the application of microdiffusion analysis eliminates these disadvantages inherent in distillation procedures, and affords a convenient method for the separation, and subsequent estimation, of volatile substances from biological materials.

The theory of microdiffusion analysis has been discussed by Conway (1). Many applications of microdiffusion analysis to toxicological problems have appeared in the literature. The technique has been utilized by Conway (1), Winnick (2), Sunshine (3), and Newman (4) for the analysis of ethyl alcohol in biological fluids, by Conway (1) for the determination of carbon monoxide in blood, and by Burbridge et al. (5) for acetaldehyde in biological fluids.

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It is the purpose of this presentation to demonstrate the application of microdiffusion analysis to the detection and estimation of most of the common volatile poisons encountered in toxicological cases. With this technique a relatively complete analysis of the volatiles may be carried out in a short period of time, using a minimum of biological material. The procedures have been specifically devised for the analysis of blood and urine samples obtained in poisoning cases but are also applicable to analysis of tissues.

Preparation of Biological Samples

Oxalated blood (whole blood) or serum and urine are used as received. Tissue samples are prepared for analysis by homogenizing a weighed amount in a Waring Blender with sufficient water to give a 1 to 5 dilution of tissue. The tissue slurry resulting from this treatment is easily pipetted and is treated exactly as blood or urine in the subsequent procedures.

Preparation of the Conway Diffusion Units

In each case to be described below the following general procedure for the use of the Conway unit is followed: an aliquot of biological sample is placed in the outer compartment and a measured volume of the appropriate absorbing solution is pipetted into the center well of the unit. The ground glass cover of the unit is smeared with silicone grease or other fixative [1] and is placed on the unit so that a small portion of the outer compartment remains uncovered. A measured volume of the appropriate liberating agent is then pipetted into the outer compartment and the lid is moved into place to cover the entire cell with an airtight seal. The unit is then gently tilted and rotated to mix the fluids in the outer compartment and allowed to stand for the indicated time to allow diffusion to be completed. When diffusion is complete, the lid is removed and an aliquot of the liquid in the center

[1] In place of silicone grease, water-soluble lubricants may be used, making the units much easier to clean. Some of these, however, oxidize the acid-dichromate reagent used for ethyl alcohol. Ucon lubricant, manufactured by Carbide and Carbon Company is the only one tested which we have found to be satisfactory for use in the determination of ethyl alcohol.

well is taken for analysis. For blood and urine determinations we have used the standard porcelain Conway cell; for analyses of tissue slurries, however, the volumes involved necessitate the use of a larger cell. Glass diffusion cells with a capacity of 5 ml. in the outer compartment may be obtained from Aloe Scientific Co.[2] The specific procedures are outlined in Tables 1 and 2.

The volatile poisons usually encountered in toxicological cases have been divided into four groups:

Group I. Volatile reducing substances which react with acid-dichromate (ethanol, methanol, isopropanol, acetaldehyde, formaldehyde).

Group IA. Volatile aldehydes and ketones absorbed by sodium bisulfite.

Group IB. Volatile alcohols absorbed by dilute sulfuric acid.

Group II. Substances which are absorbed in dilute sodium hydroxide (cyanide, sulfides, phenols).

Group III. Substances which reduce palladium chloride (carbon monoxide).

Group IV. Substances which are more soluble in toluene than in water (halogenated hydrocarbons).

GROUP I. DETERMINATION OF ETHYL ALCOHOL AND VOLATILE REDUCING SUBSTANCES

Reagents:

1. Saturated potassium carbonate.
2. Acid-dichromate: dissolve 3.70 grams analytical grade reagent potassium dichromate in 150 ml. distilled water. Carefully add 280 ml. concentrated sulfuric acid, cool, and dilute to 650 ml.

Procedure:

Outer compartment: (Porcelain Unit)
0.8 ml. blood or urine or 4 ml. tissue slurry (equivalent to 0.8 grams tissue).

[2] 5655 Kingsbury Street, St. Louis, Missouri.

TABLE 1. GENERAL SUMMARY

	Outer Compartment		*Inner Compartment*	*Diffusion Time*
Analysis	*Sample*	*Liberating Agent*		
Ethyl alcohol	0.8 ml. blood 4 ml. slurry	1 ml. K_2CO_3	2.0 ml. acid-dichromate	3 hours
Acetaldehyde	3 ml. blood 5 ml. slurry	3–4 drops 10% H_2SO_4	3.3 ml. 0.15 M sodium bisulfite	3 hours
Formaldehyde	"	"	"	"
Acetone	"	"	"	"
Methyl alcohol	2.0 ml. blood 5 ml. slurry	1 ml. K_2CO_3	3.3 ml. 10% sulfuric acid	"
Isopropanol	"	"	"	"
Cyanide	2–4 ml. blood 5 ml. slurry	3–4 drops 10% H_2SO_4	3.3 ml. 0.1 N NaOH	"
Sulfide	"	"	"	"
Phenols	"	"	"	"
Carbon monoxide	1.0 ml. blood	1.0 ml. 10% sulfuric acid	2.0 ml. palladium chloride	1 hour
Halogenated hydrocarbons	1–4 ml. blood or tissue		1.0 ml. toluene	3 hours

Center compartment:
2.0 ml. acid-dichromate solution.
Outer compartment:
(liberating agent): 1.0 ml. saturated potassium carbonate.
Diffusion time:
3 hours at room temperature for blood and urine, 4 hours at 37° for tissue, or overnight at room temperature.

TABLE 2. SCHEME FOR THE ANALYSIS OF VOLATILE SUBSTANCES BY MICRODIFFUSION ANALYSIS

Substance	*Absorbing Solution*	*Test*
Group I	$K_2Cr_2O_7$	Orange color-green orange
Group IA	$NaHSO_3$	CH_3CHO–p–hydroxydiphenyl
		CH_2O–chromotropic acid
		CH_3COCH_3–salicylaldehyde
Group IB	H_2SO_4	CH_3OH–oxidation chromotropic acid
		$CH_3CHOHCH_3$–oxidation salicylaldehyde
Group II	NaOH	CN–pyridine–barbituric acid
		S–bismuth reagent
		Phenol–Folin reagent
Group III	$PdCl_2$	Black film of Pd
Group IV	Toluene	Pyridine–alkali

Quantitative Determination:

The acid-dichromate solution is transferred from the center well with the aid of a capillary pipette and several rinsings of water to a 10 ml. graduated test tube and diluted to the mark with water. A blank consisting of 2.0 ml. of the acid-dichromate solution diluted to 10 ml. with water is prepared at the same time. The optical densities of the solutions are determined in a spectrophotometer at 450 millimicrons using

1 cm. cells, against distilled water as a reference. Standards are prepared by adding known amounts of ethyl alcohol to blood and assaying as above. The unknown is then calculated as follows:

$$(\text{density blank} - \text{density unknown}) \times F = \text{mgs. \% alcohol}$$

$$\text{where } F = \frac{\text{conc. of std. (mgs. \%)}}{\text{d blank} - \text{d standard}}$$

Using 0.8 ml. of blood or 0.8 gram of tissue, the range of concentration of alcohol which can be determined is from 0 to 300 mgs. %. In the presence of greater concentrations of alcohol, smaller aliquots of biological sample are taken for analysis. The recovery of alcohol added to biological samples is from 96–101% (Table 3). Agreement with other methods for determining alcohol in blood or tissue is excellent (Table 4).

TABLE 3. RECOVERY OF ALCOHOL ADDED TO BIOLOGICAL SAMPLES

Sample	*Alcohol added (mg. percent)*	*Alcohol found (mg. percent)*	*Recovery (percent)*
Blood	75	73	97
"	150	148	97
"	300	302	101
"	400	397	99
Urine	75	72	96
"	150	147	98
"	300	296	99
"	400	396	99
Brain	75	76	101
"	150	152	101
"	300	297	98
"	400	395	98

Discussion:

The relative concentrations of acid and dichromate in the oxidizing reagent are such that the following substances will react: ethyl alcohol, methyl alcohol, acetaldehyde, formaldehyde, and isopropyl alcohol. Acetone in concentrations as high as 200 mgs. % does not react under the conditions of the test. A positive reaction can be observed by the change in

color of the orange dichromate solution to the greenish-orange of a mixture of dichromate and chromic ions. In the absence of any color change in the center well, the above substances may be presumed to be absent. The most commonly occurring volatile in this group is ethyl alcohol, but the absence of methyl alcohol, acetaldehyde, formaldehyde, and isopropyl alcohol must be demonstrated.

TABLE 4. COMPARISON OF MICRODIFFUSION METHOD FOR ALCOHOL WITH OTHER METHODS

Sample	*Method*	*Concentration of Alcohol (mgs. %)*	
		Other Method	*Microdiffusion Method*
Blood	Dubowski (6)	175	173
"	"	250	247
"	"	385	383
"	"	396	394
Brain	Gettler (7)	73	71
"	"	186	187
"	"	197	194
"	"	276	273

GROUP IA. DETERMINATION OF ACETALDEHYDE, FORMALDEHYDE AND ACETONE

Reagents:

1. 0.15 M sodium bisulfite.
2. 10% sulfuric acid (v/v).
3. 1% p–hydroxybiphenyl in 0.5 N sodium hydroxide.
4. 0.5% chromotropic acid (freshly prepared).
5. Concentrated sulfuric acid.
6. 4% copper sulfate.
7. Acetaldehyde sodium bisulfite (Eastman).
8. Formaldehyde sodium bisulfite (Eastman).
9. Acetone sodium bisulfite (Eastman).
10. 40% sodium hydroxide.
11. Salicylaldehyde: 20 ml. diluted to 100 ml. with absolute alcohol (freshly prepared).

Procedure:

Outer compartment: (Glass Unit)

3 ml. blood or urine or 5 ml. tissue slurry (equivalent to 1 gm. tissue).

Inner compartment:

3.3 ml. 0.15 M sodium bisulfite.

Outer compartment:

(liberating agent): 3–4 drops 10% sulfuric acid.

Diffusion time:

3 hours at room temperature for blood and urine samples.

4 hours at room temperature or 2 hours at 37° C. for tissue slurry.

Qualitative and Quantitative Determination:

Into each of 3 test tubes graduated at 10 ml. is placed 1 ml. of the sodium bisulfite solution from the center well.

Acetaldehyde: To the first of these tubes is added 1 drop of 4% copper sulfate solution and 6 ml. concentrated sulfuric acid. This is followed by 0.2 ml. of the p–hydroxybiphenyl solution with constant shaking. The tube is placed in a boiling water bath for 1.5 minutes and then cooled. In the absence of formaldehyde a violet color is produced by acetaldehyde. The absence of any color is presumptive evidence of the absence of acetaldehyde and formaldehyde in the biological sample. For the quantitative determination of acetaldehyde, the optical density of the violet color is read in a spectrophotometer at 540 millimicrons against a reagent blank set at zero density. The optical density is proportional to concentration in the range of 2 to 10 micrograms of acetaldehyde. Standards are prepared from acetaldehyde sodium bisulfite dissolved in sodium bisulfite and submitted to the color development described above. Recovery of acetaldehyde added to biological samples is excellent (Table 5). When concentrations of acetaldehyde greater than 10 micrograms per ml. of sodium bisulfite are present the determination must be repeated on a smaller aliquot of biological sample. It should be remembered that in computing the final concentration in the biological sample, only 30% of the absorbing solution is used for the analysis.

TABLE 5. RECOVERY OF ACETALDEHYDE AND FORMALDEHYDE ADDED TO BIOLOGICAL SAMPLES

Sample	*Aldehyde Added (micrograms)*		*Aldehyde Recovered (micrograms)*	
	CH_3CHO	CH_2O	CH_3CHO	CH_2O
Blood	2.0	2.0	1.9	1.8
"	5.0	5.0	4.9	4.9
"	10.0	10.0	9.8	10.1
"	20.0	20.0	20.1	20.0
Brain	2.0	2.0	2.1	2.0
"	10.0	10.0	9.9	9.8
"	20.0	20.0	19.8	19.9
"	50.0	50.0	50.2	50.1

Formaldehyde: The second tube is placed in an ice bath and 0.2 ml. of chromotropic acid and 4 ml. of concentrated sulfuric acid are added. The tube is shaken and placed in a boiling water bath for 15 minutes and then cooled. In the presence of formaldehyde a pink color is formed. For the quantitative determination, the contents of the tube are diluted to 10 ml. with water and the optical density of the solutions is determined in a spectrophotometer at 580 millimicrons against a reagent blank set at zero density.

Optical density is proportional to concentration of formaldehyde in the range of 2 to 10 micrograms per ml. of sodium bisulfite solution. Standards are prepared from formaldehyde sodium bisulfite solution submitted to the color development described above. Recovery of formaldehyde added to biological material is excellent (Table 5). When concentrations of formaldehyde greater than 10 micrograms per ml. are present the determination must be repeated on a smaller aliquot of biological material.

Acetone: To the third tube is added 4 ml. of 40% sodium hydroxide and 1 ml. of salicylaldehyde solution. The tube is heated at 50–60° C. for 3 minutes and then cooled to room temperature. In the presence of acetone, a red color is produced. For quantitative determination, the contents of the tube are diluted to 10 ml. with water and the optical density

is measured in a spectrophotometer at 520 millimicrons. Standards are prepared from acetone sodium bisulfite submitted to color development as described above. The optical density is proportional to concentration of acetone in the range of 5 to 50 micrograms. Recovery of added acetone is excellent (Table 6).

TABLE 6. RECOVERY OF ACETONE ADDED TO BIOLOGICAL SAMPLES

Sample	*Acetone Added (micrograms)*	*Acetone Recovered (micrograms)*
Blood	5.0	4.8
"	8.0	8.1
"	10.0	10.1
"	15.0	14.8
Brain	5.0	4.9
"	10.0	9.8
"	20.0	20.1

Discussion:

When ethyl alcohol is the only substance of interest, the test for formaldehyde, acetaldehyde, and acetone may be done qualitatively. The absence of any color in tubes 1, 2, and 3 is proof of the absence of these substances. Acetone has already been shown not to interfere with the method for alcohol as described above. Para-hydroxybiphenyl gives a color with both acetaldehyde and formaldehyde, whereas chromotropic acid reacts with the formaldehyde only. The quantitative tests may be completed (by appropriate dilution and determination of optical density) when the actual concentration of acetaldehyde, formaldehyde, or acetone is desired.

GROUP IB. DETERMINATION OF METHANOL AND ISOPROPANOL

Reagents:

1. 0.5% chromotropic acid (freshly prepared).
2. Concentrated sulfuric acid.

3. 5% potassium permanganate.
4. Sodium bisulfite, saturated solution.
5. 10% sulfuric acid (v/v).
6. Potassium carbonate, saturated solution.
7. Salicylaldehyde, 0.1% in absolute alcohol (freshly prepared).
8. Potassium hydroxide, saturated solution.

Procedure: (Glass Unit)

Outer compartment:

2 ml. blood or urine or 5 ml. tissue slurry (equivalent to 1 gm. tissue).

Center compartment:

3.3 ml. 10% sulfuric acid.

Outer compartment:

(liberating agent): 1.0 ml. saturated potassium carbonate solution.

Diffusion time:

For blood and urine 3 hours at room temperature, for tissue 5 hours at room temperature.

Quantitative Determination:

Place 1.0 ml. of the absorbing solution into each of three test tubes graduated at 10 ml.

Isopropanol: To the first of these tubes, add one drop of 5% potassium permanganate. Allow to stand for 10 minutes, after which saturated sodium bisulfite is added dropwise until the permanganate color disappears (usually one drop will suffice). Then add 1.0 ml. of the salicylaldehyde, followed by 2 ml. of saturated potassium hydroxide. Heat the tube in a boiling water bath for 2 minutes and allow it to cool. In the absence of acetone and acetaldehyde, the formation of a red color is indicative of isopropanol. Dilute the contents of the tube to 10 ml. and filter. The optical density is determined in a spectrophotometer at 520 millimicrons against a reagent blank set at zero density. Standards are prepared from pure isopropanol solutions treated as described above.

Methanol: To one of the remaining two test tubes add one drop of 5% potassium permanganate. Allow to stand 10 min-

utes. To each of the tubes add one drop of saturated sodium bisulfite to decolorize the permanganate. To each tube add 0.2 ml. of 0.5% chromotropic acid solution. Place in an ice bath and add 4 ml. concentrated sulfuric acid to each tube. Place the tubes in a boiling water bath for 15 minutes, cool, and dilute to 10 ml. Read in a spectrophotometer at 580 millimicrons against a water blank. The optical density of the solution to which no permanganate has been added (formaldehyde) must be subtracted from the density of the oxidized solution. Gross contamination with formaldehyde makes this method inapplicable. Standards are prepared in 10% sulfuric acid, 1.0 ml. of which is treated as above. Results must be multiplied by 1.21 to correct for the 85% diffusion in the case of blood or urine. For tissue determinations, the factor must be calculated from recovery of added alcohol to samples of tissue. In computing the final concentration in the biological sample, it should be remembered that only 30% of the contents of the center cup are used in the analysis.

Discussion:

The absence of any color with chromotropic acid or with salicylaldehyde is presumptive evidence of the absence of methanol and isopropanol. Data have been obtained (8) indicating that methanol can be recovered quantitatively (Table 7) and that the method can be used for biological samples containing as little as 0.5 mg. % of methyl alcohol. Isopropanol can be recovered with an error of ± 5% in the range of concentration of 10 to 100 mgs. % (Table 8). Inasmuch as the diffusion for these two alcohols is an equilibrium process rather than conversion to a substance with zero vapor pressure, it is advisable for quantitative purposes to perform the tests for methanol and isopropanol in separate porcelain Conway units using 2.2 ml. of absorbing solution in the center well.

TABLE 7. RECOVERY OF METHANOL FROM BIOLOGICAL FLUIDS

Alcohol Added mg.	Alcohol Found *Blood* Found mg.	Recovery %	Recovery Corrected %[1]	Alcohol Found *Urine* Found mg.	Recovery %	Recovery Corrected %[1]	Alcohol Found *Spinal Fluid* Found mg.	Recovery %	Recovery Corrected %[1]
0.0100	0.0081[2]	81	98.5	0.0082[2]	82	99.5	0.0084	84	102.0
	0.0083	83	100.0	0.0084	84	102.0	0.0082	82	99.5
	0.0082	82	99.5	0.0082	82	99.5	0.0080	80	97.0
0.0300	0.0255[2]	85	103.0	0.0244[2]	81	98.5	0.0246	82	99.5
	0.0250	83	100.0	0.0255	84	102.0	0.0250	83	100.0
	0.0250	83	100.0	0.0250	83	100.0	0.0244	81	98.5
0.0500	0.0400[2]	80	97.0	0.0410[2]	82	99.5	0.0425	85	103.0
	0.0410	82	99.5	0.0400	80	97.0	0.0410	82	99.5
	0.0420	84	102.0	0.0420	84	102.0	0.0415	83	100.0
0.0800	0.0655[2]	82	99.5	0.0650[2]	81	98.5	0.0650	81	98.5
	0.0640	80	97.0	0.0644	80	97.0	0.0660	83	100.0
	0.0660	83	100.0	0.0671	84	102.0	0.0671	84	102.0

[1] Multiplied by diffusion correction factor 1.21.
[2] In the presence of 1.0 mg. of ethyl alcohol.

TABLE 8. RECOVERY OF ISOPROPANOL ADDED TO BIOLOGICAL SAMPLES

Sample	*Isopropanol Added (mgs. percent)*	*Isopropanol Recovered (mgs. percent)*	*Recovery (percent)*
Blood	10.0	9.5	95
"	20.0	19.1	96
"	50.0	48.3	96
Brain	20.0	18.7	94
"	35.0	33.8	97
"	100.0	97.3	97

GROUP II. DETERMINATION OF CYANIDE, SULFIDE, AND PHENOLS

Reagents:

1. Sulfuric acid 10% (v/v).
2. Sodium hydroxide 0.1 N.
3. Sodium hydroxide 10%.
4. Sodium phosphate monobasic, 1 Molar.
5. 0.25% chloramine T (keep refrigerated).
6. Pyridine-Barbituric acid reagent (10): 3 grams barbituric acid, 15 ml. pyridine, and 3 ml. concentrated hydrochloric acid are placed in a 50 ml. volumetric flask. The solution is mixed to dissolve the reagents, diluted to volume with water, and filtered. This solution must be prepared fresh each time it is used.
7. Folin-Ciocalteu Phenol Reagent (11).
8. Bismuth reagent: dissolve 4.28 grams bismuth nitrate pentahydrate in 300 ml. glacial acetic acid and add 1.5 liters of water.

Procedure: (Glass Unit)

Outer compartment:

2–4 ml. blood or urine, or 5 ml. tissue slurry (equivalent to 1 gram tissue).

Center compartment:

3.3 ml. 0.1 N sodium hydroxide.

Outer compartment:

(liberating agent) 3–4 drops 10% sulfuric acid.

Diffusion time:
3–4 hours at room temperature.

Quantitative Determination:

Place 1.0 ml. of the absorbing solution into each of three test tubes graduated at 10 ml.

Cyanide: Prepare a blank consisting of 1.0 ml. of 0.1 N sodium hydroxide in a test tube. To both the blank and the unknown add 2.0 ml. of 1 M sodium acid phosphate and 1.0 ml. of chloramine T solution. Mix and allow to stand for 2–3 minutes. This is followed by the addition of 3.0 ml. of the pyridine barbituric acid reagent. The contents of the tubes are mixed and allowed to stand for 10 minutes. The presence of a red color is indicative of the presence of cyanide. The optical density is determined in a spectrophotometer at 580 millimicrons with the blank set at zero density.

Standard solutions of sodium cyanide containing 0.1 to 2.0 micrograms of cyanide per milliliter of 0.1 N sodium hydroxide are prepared and the color is developed as above. Concentrations of cyanide in the range from 0.1 to 2.0 micrograms can be determined. Recovery of cyanide added to biological samples is excellent (Table 9).

TABLE 9. RECOVERY OF CYANIDE ADDED TO PLASMA, URINE AND TISSUE HOMOGENATES

Cyanide Present (micrograms per sample)	*Cyanide Recovered*	
	Micrograms	*Percent*
0.100	0.102	100
0.100	0.096	96
0.500	0.480	96
0.500	0.510	101
0.500	0.490	98
1.000	0.960	96
1.000	0.980	98
1.000	1.020	102
2.000	1.960	98
2.000	2.020	101

Sulfide: To the second test tube containing 1 ml. of the absorbing solution add 1 ml. of bismuth reagent and dilute to 5 ml. with water. Nitrogen is bubbled through the solution to remove oxygen and the optical density is determined in a spectrophotometer at 350 millimicrons against a reagent blank set at zero density. The absence of any brown color of bismuth sulfide is evidence of the absence of sulfide in the biological sample. The procedure will detect 5 micrograms of sulfide. Recovery of added sulfide is excellent (Table 10). Standards are prepared from pure sodium sulfide treated as described above.

TABLE 10. RECOVERY OF SULFIDE ADDED TO BIOLOGICAL SAMPLES

Sulfide added (mg. percent)	*Sulfide recovered (mg. percent)*	*Recovery (percent)*
0.60	0.55	92
1.00	0.94	94
2.00	2.01	100
5.00	4.93	98

Phenols: To the third tube containing 1 ml. of the absorbing solution add 2–3 drops of 10% sodium hydroxide and 0.5 ml. dilute (1:3) phenol reagent. The solution is diluted to 10 ml. and the optical density is determined in a spectrophotometer at 700 millimicrons against a reagent blank set at zero density. The absence of any blue color is evidence of the absence of volatile phenols in the biological sample. Standards are prepared from phenol treated as described above.

GROUP III. DETERMINATION OF CARBON MONOXIDE

Reagents:

1. Palladium chloride: dissolve 0.22 grams palladium chloride in 250 ml. of 0.01 N hydrochloric acid, heating if necessary to effect solution.
2. Sulfuric acid 10%.
3. 0.1% gum ghatti.
4. 15% potassium iodide.

Procedure:

Outer compartment:
1.0 ml. blood.
Center compartment:
2.0 ml. palladium chloride solution.
Outer compartment:
(liberating agent) 1.0 ml. 10% sulfuric acid.
Diffusion time:
1 hour at room temperature.

If there is no change in the palladium chloride solution the test may be presumed to be negative. In the presence of carbon monoxide, a silvery film of metallic palladium will appear on the surface. With the aid of a capillary pipette remove the unreacted palladium chloride solution from beneath the metallic precipitate and transfer to a test tube. Using a 0.1 ml. pipette, transfer 0.1 ml. of this palladium solution to a 10 ml. volumetric flask. To a second 10 ml. volumetric flask, add 1.0 ml. of the original palladium chloride solution. To each flask add 1.0 ml. of 0.1% gum ghatti solution and 1.0 ml. 15% potassium iodide. Dilute to volume and mix. Read the optical density at 500 millimicrons against distilled water set at zero density.

Calculation:

(0.1 ml. 0.01 N palladium chloride = 0.0528 mg. palladium)
(1 mg. palladium = 0.21 mg. carbon monoxide)
(density of control — density of unknown) $\times$

$$\left[\frac{0.0528}{\text{density of control}}\right] \times 420 = \text{Vols. \% CO}$$

$$\frac{\text{Vol. \% CO content}}{\text{Gms. Hb per 100 ml. blood} \times 1.34} = \text{\% saturation}$$

Discussion:

The method is based on the reduction of palladium ion to metallic palladium which appears as a silvery black film on the surface of the center compartment of the Conway unit. The method serves as an excellent screening test for carbon monoxide in addition to being a quantitative procedure since

the absence of any silvery black film on the surface of the palladium chloride solution is presumptive evidence of the absence of carbon monoxide.

GROUP IV. DETERMINATION OF HALOGENATED HYDROCARBONS

Reagents:

1. Pyridine, reagent grade.
2. Sodium hydroxide 20%.
3. Toluene (sulfur-free).

Procedure:

Outer compartment: (glass unit)
1–4 ml. blood, urine or tissue slurry.
Center compartment:
1.0 ml. toluene.
Diffusion time:
2 hours at 37° C. or 3 hours at room temperature.

Place 0.5 ml. of the toluene solution from the center well in a test tube. Prepare a blank consisting of 0.5 ml. of toluene in a second tube. To each add 5 ml. pyridine and 2.5 ml. 20% sodium hydroxide. Mix, and place both tubes in a boiling water bath for exactly 5 minutes. The presence of a red color in the pyridine layer of the unknown is indicative of the presence of a halogenated hydrocarbon. Cool in ice water and transfer 4 ml. of the pyridine layer to a test tube. Add 1.0 ml. water to remove any turbidity. The resulting color is stable for one hour. Measure the optical density at 530 millimicrons, against the reagent blank set at zero density. A calibration curve is prepared by adding known amounts of chloroform, carbon tetrachloride or trichloroethylene to biological samples and submitting to diffusion and color development as described above. Concentrations of these substances from 5 to 35 mgs. % may be determined with an error of ± 5% (1) (Table 11).

TABLE 11. ANALYSIS OF BIOLOGICAL SPECIMENS FOR HALOGENATED HYDROCARBONS

(Blood, urine, and tissue homogenate)

Amount present (mgs. percent)	*Amount found (mgs. %)*	*% Recovery*
25.0	24.0	96
15.0	15.5	103
35.0	34.5	98
10.0	9.5	95

Discussion:

Since this test is sufficiently sensitive to react to fumes of halogenated hydrocarbons which may be present in the air of the laboratory, precautions must be taken to carry out the test in a room completely free of such vapors.

Summary:

The volatile poisons have been divided into four groups, based on their diffusion characteristics. A technique has been described for the detection and estimation of these in biological materials. Recovery of members of each group added to blood, urine and tissue is excellent, and the micro-diffusion process has been shown to be rapid, convenient, and specific. A complete analysis for the volatile unknowns may be completed in 3–4 hours with as little as 5 ml. of blood. Most of this time is taken up by the diffusion process leaving the analyst free for other work. Any member of any group may be determined separately if desired; for example, should cyanide be in question, the procedure for separation and estimation of cyanide given here may be carried out quite independently of the rest of the volatiles.

REFERENCES

1. Conway, E. J.: Microdiffusion Analysis and Volumetric Error, D. Van Nostrand Co., 1950.
2. Winnick, T.: Determination of Ethyl Alcohol by Microdiffusion, Ind. Eng. Chem. Anal. Ed. 14:523–5, 1942.

3. Sunshine, I. and Nenad, R.: A Modification of Winnick's Method for the Rapid Determination of Ethyl Alcohol in Biological Fluids, Anal. Chem. 25:653–5, 1953.
4. Newman, E. J. and Newman, H. W.: A Microdiffusion Method for Alcohol Determination, Stanford Med. Bull. 11:96–9, 1953.
5. Burbridge, T. N., Hine, C. H., Bowman, K. P., Simon, A., Macklin, E. and Schick, A.: Semi-micro Determination of Ethyl Alcohol and Acetaldehyde in Biological Fluids, J. Pharmacol. Exp. Therap. 98: No. 1, 1950.
6. Dubowski, K. M. and Withrow, J. R.: A Photometric Microdiffusion Method for Ethyl Alcohol in Biological Materials, Proc. Amer. Acad. Forensic Sci. 2:323–7, 1952.
7. Gettler, A. O. and Tiber, A.: The Quantitative Determination of Ethyl Alcohol in Human Tissues, Arch. Path. and Lab. Med. 3:75–8, 1927.
8. Feldstein, M. and Klendshoj, N. C.: Determination of Methanol in Biological Fluids by Microdiffusion Analysis, Anal. Chem. 26:932–3, 1954.
9. Feldstein, M. and Klendshoj, N. C.: The Determination of Cyanide in Biological Fluids by Microdiffusion Analysis, Can. J. Med. Tech. 17:29–32, 1955.
10. Asmus, E. and Garschagen, H.: The Use of Barbituric Acid for the Photometric Determination of Cyanide and Thiocyanate, Z. anal. Chem. 138:414–22, 1953.
11. Folin, O. and Ciocalteu, V.: On Tyrosine and Tryptophane Determination in Proteins, J. Biol. Chem. 73:627, 1927.
12. Feldstein, M. and Klendshoj, N. C.: Microdiffusion Analysis as Applied to Toxicology, Proc. Amer. Acad. Forensic Sci. 2:48–53, 1952.

Department of Legal Medicine
University of Buffalo School of Medicine
Department of Biochemistry
Buffalo General Hospital
Buffalo, New York

The Future of Court Psychiatry*

William H. Haines, M.D., Chicago, Ill.

The year 1956 marks the twenty-fifth anniversary of the Behavior Clinic of the Criminal Court of Cook County, Illinois. It came into being in 1931 at the instigation of the Chicago Medical Society, the Chicago Neurological Society, the Institute of Medicine, the Chicago Bar Association, and the Chief Justice of the Criminal Court, who at the time was Judge John P. McGoorty.

The primary purpose of the Behavior Clinic was to examine defendants charged with crimes who were unable to hire private psychiatrists, so that the poorest defendant would be able to secure the same psychiatric examination and testimony as the wealthiest defendant. The services of the Clinic were to be offered to all defendants, regardless of ability to pay. The report to court was to be submitted in triplicate so that the State, the Defense, and the Court each would have a similar copy of the findings.

The secondary function of the Clinic was to examine those who were being considered for probation, and to advise the Court as to their mental condition, prior to probation. However, this latter function was soon found to be impracticable, due to the large number of indictments in the Criminal Court and the limited facilities of the Clinic. The efforts of the Behavior Clinic were then confined to the mental condition of defendants prior to trial.

We are approaching our 9000th examination. I have been the Director since 1941. I am called to testify in court approximately 150 times a year, either at the request of the

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Defense or the State—occasionally by order of the Court. The greatest number of our requests to testify come from the defense attorneys. The Behavior Clinic does not examine defendants, nor do I testify in court, unless a court order for the examination has been entered. Occasionally the strategy of the defense attorney is to enter an order at the time of the hearing, and I will be called to testify. I will testify that I did not examine the real defendant and the defense will then ask a hypothetical question, or I will be used as an expert witness. In a few instances my testimony has been limited by the Court to the legal definition of sanity at the time of the trial or hearing.

In Chicago we have three Psychiatric Court Clinics:

1. The Family Court, formerly the Juvenile Court, has a Psychiatric Department which examines approximately 750 a year.
2. The Municipal Court has the Psychiatric Institute, which examines approximately 4000 cases a year.
3. The Criminal Court of Cook County has the Behavior Clinic, which examines approximately 500 a year.

As mentioned above, the Behavior Clinic examines only upon order of Court. The request must come from the defense attorney, as under the law in the State of Illinois neither the Court nor the State's Attorney has the right to order a mental examination of a defendant after indictment, prior to trial. If the Court had that authority then its psychiatrist in the eyes of the jury would be the only impartial psychiatrist in the courtroom.

If the defendant comes in the courtroom insane, that is, if he is an escapee from a mental institution, or has otherwise been adjudicated insane, it is then proper for the State to request a sanity hearing, for the purpose of finding the individual legally sane, so that there will be no question as to the individual's sanity at the time of impaneling the jury for trial on the indictment.

A restoration must be held on every defendant before the Court who has ever been committed as feebleminded or insane (mentally ill), in order to prevent a reversal of the

sentence at some future time. This must be before a jury of twelve.

Cook County returns approximately 3000 indictments a year. At the present time there are around 2300 in the County Jail awaiting sentence or serving sentence. The jail was originally built for around 1200. One can readily see how emotional difficulties will occur under such overcrowded conditions.

Our report to court is presented in triplicate so that the Judge, at his discretion, may give a copy to the Defense Attorney and the State's Attorney. We are not permitted to mention in the report any previous incarceration in penal institutions, nor are we permitted to refer to, or comment on, the offense for which the individual is being tried.

The examination consists of the following:

1. A physical examination.
2. A psychological examination, with the impression of the examining psychologist. One must always remember that the I. Q. is not lower than that obtained, but may be higher, depending upon the desire of the patient to cooperate, or to be found insane by reason of feeblemindedness.
3. A resumé of the social history.
4. A resumé of the mental examination.
5. The conclusions:
   (a) A medical diagnosis.
   (b) The legal terminology of sanity at the time of impaneling the jury for trial or the sanity hearing. This is mainly—does he know the nature of the charge and he is able to cooperate with his counsel. If either of the last two are answered in the negative it is a notice to the Court that the individual is insane. It is then mandatory that a jury of twelve be impaneled and a sanity hearing be held.

If there is a sanity hearing, then the hearing is quasi-criminal and the rules are that of a civil proceeding, i. e., "A preponderance of the evidence," or a slight tipping of the scales. If it is insanity at the time of the offense then

the rules are according to the Criminal Code, i. e., "Beyond a reasonable doubt," or a complete tipping of the scales. In Illinois one may be:

1. Insane at the time of the offense but sane at the time of going to trial.
2. Insane at the time of the offense and insane at the time of going to trial.
3. Sane at the time of the offense and insane before going to trial.
4. Sane at the time of the offense and become insane during the trial.
5. Sane at the time of the offense and become insane before sentence.
6. Sane at the time of the offense and become insane before execution of sentence.

The State of Illinois has special tests to establish insanity (responsibility) of an individual at various stages of the trial:

At the Commission of a Crime: When an accused person is put on trial for a crime or misdemeanor, the correct test as to insanity is whether or not the defendant is capable of knowing right from wrong as to the act in question, and is capable of exercising the power of choosing either to do or not do the act, and of governing his conduct in accordance with such choice.

Before Trial: He is not considered a lunatic or insane if he is capable of understanding the nature and object of the proceedings against him; if he rightly comprehends his own condition in reference to such proceedings, and has sufficient mind to conduct his defense in a rational or reasonable manner although upon some other subjects his mind may be deranged or unsound.

Before Judgment: A person who becomes lunatic or insane after the commission of a crime or misdemeanor shall not be tried for the offense during the continuance of the lunacy or insanity. If, after the verdict of guilty, and before judgment is pronounced, such person becomes lunatic or insane, then no judgment shall be given while such lunacy or insanity shall continue. And if, after judgment and before

execution of the sentence, such person becomes lunatic or insane, then in case the judgment be capital, the execution thereof shall be stayed until the recovery of said person from the insanity or lunacy. In all of these cases, it shall be the duty of the Court to impanel a jury to try the question whether the accused be, at the time of impaneling, insane or lunatic.

Before Execution: The defendant before execution is to be regarded as sane and not lunatic, when he has sufficient intelligence to understand the nature of the proceedings against him, what he was tried for originally, the purpose of his punishment, the impending fate which awaits him, and a sufficient mind to know any facts which might exist which would make his punishment unjust or unlawful, and sufficient of intelligence to convey such information to his attorney or the court. When he has not such intelligence and mental ability he is to be regarded as insane or lunatic by the verdict of the jury, if so found, and his execution stayed or delayed.

The same tests apply for feeblemindedness and insanity in Illinois, that is, one must not be able to distinguish between right and wrong, and must not be able to cooperate with counsel.

Considerable interest has been shown recently in the Durham decision in Washington. In Illinois we are influenced by the M'Naghten Rules, which were responses made by fifteen judges in England in 1843 to five questions put to them by the House of Lords. Our own Illinois Supreme Court opinions are based on these rules.

Roughly, the M'Naghten Rules are (A person is not criminally responsible for an offense if at the time the act is committed he is mentally unsound as to lack of knowledge that the act is wrong. This is called the "right-and-wrong" test, and is law in all but two of our states. It is the sole test of irresponsibility in England and in twenty-nine American states. The wording of the rule varies considerably: in at least half the cases it is stated that to be excused the defendant must be so disordered as not to know the "nature and quality" (sometimes "nature and character," "conse-

quence," etc.) of the act, or if he did know it, that he did not know it was wrong.

Since 1843 in seventeen of our states will power enough to resist the impulse to commit a crime has been added to the knowledge that the act is wrong.

To repeat, twenty-nine states base criminal responsibility on knowledge of the so-called "right-and-wrong" test: seventeen states and the District of Columbia add the second test of irresistible impulse. In these latter jurisdictions a person is excused if he is incapable of knowing the wrongfulness of the act, or even though he does know it is wrong, if he is incapable of controlling the impulse to commit the act.

In New Hampshire the Court has rejected both of these tests and has a rule that there is no legal test of irresponsibility by reason of insanity: "It is a question in fact for the jury in each case, whether the defendant has a mental disease, and if so, whether it was of such a character or degree to take away the capacity to form or entertain a criminal intent."

In Rhode Island the Court has never passed upon the question of a legal test of insanity.

In Nebraska feeblemindedness and mental disease have been held grounds for mitigating punishment.

In Illinois if a defendant is found insane he is committed to Illinois Security Hospital until such time as he is "totally and permanently recovered." He is then returned to the custody of the Sheriff to stand trial on his original indictment.

The Illinois Security Hospital is a hospital of maximum security. It is about sixty miles south of St. Louis in the town of Chester. The hospital has a population of about four hundred and is under the jurisdiction of the Department of Public Welfare, Transfers may be made to it, from the other State Hospitals, of homicidal patients, escapees, behavior problems, etc., upon departmental order.

The prison system has the Psychiatric Division, which is a walled institution within the Illinois Southern Penitentiary, on property adjoining the Security Hospital. The Psychi-

atric Division is for insane criminals, sexual deviates, behavior problems, etc. It has a census of about six hundred, and is under the jurisdiction of the Department of Public Safety.

One example of a trial on the indictment after hospitalization is the case of a general paretic who was examined by the Behavior Clinic and found to be insane at the time of the impaneling of the jury, many months after the crime. I had seen and treated this individual as a patient, in the Neurological Dispensary of Rush Medical College, many years before. After a period of seven years in the hospital he was found to have recovered his sanity and was returned to the court. I was subpoenaed by the defense attorney to testify as to the mental condition at the time of the alleged crime. My testimony was limited by the Court to my own personal mental examination. I did not make the physical examination, so I was not permitted to testify as to the fixed pupils and the neurological findings. I was not permitted to testify that he had syphilis, in that I did not draw the blood and run the serological test. I was not permitted to testify for which disease I had treated him in the Central Free Dispensary of Rush Medical College, as I again did not draw blood and determine the serology. It was all hearsay evidence. I was permitted to testify that I had given him a prescription, and the name of the medicine I prescribed. The Court ruled that inasmuch as my mental examination had been performed many months after the commission of the crime, I should not be permitted to give an opinion as to his mental state at the time of the crime. The defendant was sentenced to forty years in the penitentiary.

Frequently claims of insanity are used by the defense to delay a trial, to tire out the witnesses, etc. A case may be ready to go to trial when the defense brings before the Court the issue of insanity. It is then mandatory for that issue to be disposed of before the trial can proceed. When the defense attorney can provide no other defense he can always claim that the defendant was temporarily insane and has now recovered, so that he would not have been responsible at the time of the commission of the crime. We had one patient who claimed to be insane after three o'clock in the

afternoon, at which time the jail was closed and we were not able to observe him in his so-called periods of insanity.

If the prisoner is facing the electric chair one must be suspicious of malingering We had one patient, charged with murder, on whom we were about to report to Court that he was unable to cooperate with his counsel, based upon his mental examination. However, a letter which he attempted to pass to his wife during a visit was intercepted by a jail guard. This letter read in part: "I am not supposed to be aware of anything, as I am supposed to be crazy. I want to impart some information to you which you in turn will give to the lawyer representing me. Don't you realize that my life hangs in the balance, that everything depends on you, as I put my trust in you? So please, for God's sake, heed my words. Don't you realize that they want to make an example of me and put me in the electric chair, even though they may not be able to do it if I go to trial? It is too late to turn back now. I have gone too far and they are mad at me because if I am pronounced insane it will spoil the State's case and they will have to commit me to the Psychiatric Division until I am cured, and then I will come back to have a chance to beat the rap, because I can contend that I was not responsible for my actions. After you have copied the information burn this letter. I want you to volunteer this information of your own accord because you naturally know all about my life." He then gave a list of friends to call upon to testify that he gave the impression of being "unstable, irrational and unsettled"; that he would always lose interest in things he was doing; that he would begin a conversation and suddenly stop in the middle of it and start roaming; that he would sit and stare into space for long periods of time, and he would pay no attention to those about him. He advised that all his friends be informed of this and then that they be subpoenaed to testify in court. In a twelve-page letter he outlined the steps one by one. Confronted with this evidence his behavior changed immediately. He submitted again to a mental examination and no overt signs of mental disease were elicited.

We have had individuals come to court acting in a very bizarre manner and the jury would find them insane. As soon as they leave the courtroom their behavior would be normal. One, charged with murder, entered the courtroom in a disheveled fashion, and during the court procedure threw his shoes and socks around the floor. As it was in wintertime and the stone floors were cold, it was noted that he attempted to reach his socks with his feet, in order not to touch the cold floor. His sister was an excellent witness in his defense, collapsing on the stand. Later it was learned that she had taken dramatic lessons to prepare her for her court appearance.

We have had many interesting cases. Fear plays a large role in many instances. I have seen a man drop dead after leaving the witness stand; another attempt to dash through a barred window before going into the courtroom, although his offense was a minor one and probation had been assured him. Some attempt suicide and are successful. Others become panicky, others mute, some combative, some have epileptic seizures, others faint or have heart attacks.

Our greatest difficulty is with defense lawyers in cases of psychoneuroses and psychopathic personalities. Anyone who shows the slightest deviation in behavior from normal, or who was retarded in school, is considered by his counsel to be insane in order to avoid the consequences of his acts. If the charge is serious and the individual has previously been committed as feebleminded or mentally ill, the defense tries to avoid the legal tests and attempts to have him committed civilly. This is especially true in the border-line mental defectives and veterans receiving compensation.

Our Civil Code for commitments does not apply to those charged with crime.

The question is often raised: Just what type of patient does the Behavior Clinic examine? To answer that I have taken referrals for a month in the not too distant past. The total examined was forty-seven, six of whom were under 21 years of age. During the month I testified in court thirteen times, either at the request of the State or for the Defense.

The charges were as follows:

Crime vs. Children	2
Crime vs. Nature	1
Contributing to Delinquency of a Minor	7
Indecent Exposure	1
Abortion	1
Manslaughter	1
Attempt to Murder	1
Murder	6
Larceny	3
Burglary	3
Robbery	12
Arson	2
Forgery	1
Narcotics	1
Disorderly Conduct	3
No Complaint (one witness and one writ filed by an inmate of an institution for the mentally defective)	2

One of those examined was a female.

Thirty-one were referred by the Criminal Court; seven from the Municipal Courts; one from the Family Court; three from Justices of the Peace in outlying districts, and there were five writs from institutionalized patients asking for their release. Forty-one had previously been arrested for various charges. Thirty-four gave a history of excessive alcoholism. Nine out of forty-seven were, or had been, using drugs. Ten of the forty-seven were found to be insane and were committed to Illinois Security Hospital. Five were examined to determine whether they were sexually dangerous persons. Those found to so classify were committed as wards of the Director of Public Safety under the new "Sexually Dangerous Persons Act."

It is alarming to note the increase in pornographic literature and pictures. One of those arrested had a stolen camera. When the police came to his apartment to investigate they found a huge collection of obscene pictures. One series in-

volved bestiality. This defendant stated that he had been collecting obscene pictures for many, many years. He had been overseas in India and the Far East. He made many copies of these for the officers. He stated that he had huge albums of pictures when he returned to the States, but that these were stolen from him soon after his arrival. He told of a certain drug store in the south side that would rent the pictures for party purposes. He would take the pictures, go home and promptly make reproductions of them.

Another who was arrested for indecent exposure stated that he had made obscene pictures for a "fast buck." He hired couples for $3.00 an hour to pose in various sexual acts. He took pictures with a polarized camera and then sold them. I was recently told of a new procedure of one company that sent such pictures through the mail. The recipients of the pictures knew the procedure, which was to open them in the dark and expose them to certain solutions. If the packages were opened by the postal inspectors or the police, the exposure to the light would destroy the picture.

In the "Sexually Dangerous Persons" group we had one who denied the present charge. However, he had been examined by the Behavior Clinic in 1941, at which time he readily admitted sexual involvement with children. Another in this group would kidnap young boys for sexual purposes. One murderer under the influence of alcohol killed his victim and literally chewed off parts of her body. Another diagnosed as a Sexually Dangerous Person was employed by the City supervising and teaching young children. He made it a point to meet the families of the children and gain their confidence. He then would take the children out for immoral purposes. Of late he had been working on the 3:00 p. m. to 12:00 midnight shift, so that he would not be on the streets when children were coming home from school.

One, on a charge of contributing to the delinquency of a child, had young boys beat him with a rod in order to excite him, at which time he would masturbate in their presence.

Of those examined, one was a witness who had motor-aphasia, the result of being struck and shot during a holdup.

The Court ordered the examination, thinking that he might be intoxicated at the time of his appearance as a witness. Another had epilepsy. One of the two arsonists had been examined by the Behavior Clinic several years ago and his behavior was repeated under alcohol. In other words, under the influence of alcohol he would set fires. The other was an 18-year-old boy who readily admitted setting several hundred fires in his life. He denied any sexual thrill from setting the fires. He had served time but had not profited by his past incarceration.

Suicidal attempts are frequent in the County Jail. Occasionally an inmate succeeds. If he has ever attempted suicide the defense attorney, if he has no other defense, frequently calls this a form of insanity to disclaim responsibility. Of the forty-seven, one had attempted suicide in the County Jail which, from the description, appeared to be a genuine attempt. He was facing the habitual count. Another attempted suicide at home, but his mother waited until late the next day before she took him to see a doctor at a psychiatric clinic. He was certified to the Cook County Psychopathic Hopital, and was admitted. Again, anyone charged with crime cannot be committed civilly, under the laws of the State of Illinois. This young boy had been involved in some robberies and was removed from the Psychopathic Hospital to the County Jail. He did not later try or attempt suicide while in the jail.

What is the future of Forensic Psychiatry in the State of Illinois, and how can it be improved?

My recommendations for the future improvement are:

(1) To create a building under the supervision of the Department of Public Welfare in the northern section of Illinois, or possibly on the grounds of Chicago State Hospital, to house those from the entire state where after indictment the question of insanity has been raised. Now we have a Behavior Clinic which functions for courts in Cook County, but outside of Cook County the State's Attorneys must rely upon psychiatrists who are willing to come to examine and later

testify. In some counties they have no psychiatrists. As I understand it, one county in Illinois has only one physician, so that it is necessary to impanel juries for commitments in civil cases. The Mental Health Act requires two doctors in a county to act as a commission for civil commitments. A Forensic Diagnostic Center could perform a complete physical, psychological and mental examination. The doctors could also testify when needed in various counties of the state. Possibly a wing of the Cook County Jail could be set aside for observational purposes, the State to reimburse the County for the expenses involved.

(2) Legislation should be enacted to provide for a panel of psychiatrists to be appointed by the Court and made available to both sides. The psychiatrists testifying in court should have access to ALL information held by both sides, to avoid partiality. Their fees should be paid by the State.

(3) The hypothetical question should be abolished.

(4) The psychiatrist should be permitted to testify along medical lines so far as it is humanly possible to do so. He should not be limited to the rigid interpretation of the M'Naghten Rules. As it is now, he is not permitted to express his opinion in court, except on evidence which has already been introduced. A pretrial conference of psychiatrists would be of value in that they could discuss their findings and reach points of agreement.

(5) The sanity issue should be abolished. The defendant could be tried on the offense charged and then, if guilty, psychiatry could be used to assist or aid in the disposition.

(6) The newspapers should not glamorize crime.

(7) Many lawyers expect the psychiatrists to determine the guilt or innocence of their client. Psychiatrists should concern themselves only with the mental condition of the accused and not sit in judgment. Legisla-

tion should be enacted so that the examinations could be considered as a privileged communication.

Behavior Clinic
Criminal Court Building
2600 South California Ave.
Chicago 8, Illinois

PLAN NOW TO ATTEND

THE ANNUAL MEETING

of the

AMERICAN ACADEMY OF FORENSIC SCIENCES

Chicago, Illinois—Drake Hotel

February 28, March 1–2, 1957

Effective Expert Testimony and Compensation for Expert Witness

Editor's Note: The following four articles relating to the use of expert testimony in the trial of a law suit and the fee that an expert witness is entitled to demand for his services were all read at the annual meeting of the American Academy of Forensic Sciences in Chicago, February 23–25, 1956. They were unrelated in their presentation, three being read before different sessions of the general meeting and one before a section meeting. They are so closely related in subject matter, however, that much benefit will be derived by presenting them as a unit here.

Elements of Effective Expert Testimony

Ordway Hilton, M.A., New York, N. Y.

Expert testimony informs those who must decide a legal dispute or a criminal charge what a scientific witness' laboratory findings are. These findings frequently are a controlling or highly significant factor in the case. Oftentimes the verdict is consistent with them, but sometimes it is not.

The quality of the expert testimony has a direct bearing on why certain of these cases are won while others are lost. It is easy enough to dismiss defeats as the uncertainty of jury verdicts or the prejudices of certain judges. How much oftener, though, is the decision the result of ineffective expert testimony? And for that matter how often are cases won despite ineffective testimony only because the jury finds the expert's subject of sufficient interest that each is attentive to even a poor presentation? With the courtroom jury we have

"a captive audience"—to use a term common to the advertising field—an audience that must stay and listen. Do we really make the most of this advantageous situation?

The expert witness should actually stand out in every trial because of the high quality of his testimony. He is an experienced witness—one who has been through numerous trials. He knows, probably better than any witness in the case, the facts he is to present. Many times he can review them a short time before trial whereas an eyewitness cannot. Certainly all his laboratory notes were made knowing he might be called as a witness. How often does an eyewitness to an event even suspect he will later take the witness stand? When testifying, the expert is given greater freedom by progressive courts than the lay witness. He can detail his reasons and explain his reasoning. He is allowed visual aids—photographs, charts, instruments—to demonstrate his findings. Of all these, though, the repeated opportunity to testify, to gain courtroom experience, should be his most productive means of making him a more proficient witness.

For What Should We Strive?

For what should we strive? For the jury, the judge, all who are present in the courtroom to understand fully our laboratory findings, to appreciate how they were reached, and to believe in their accuracy.

Our story needs to be told with clarity, simplicity, thoroughness, emphasis, and fairness, and in a way that the hearer's attention is held throughout. Yet the courtroom has an atmosphere of formality, and our specialty, scientific complexity. Under these conditions we must talk to twelve "average" men and women—men and women, many of whom spend most of their leisure time with TV, at the movies, with magazines like *Life* and *Look*, or with the comics. Some may be well educated, "intellectuals," but others will be below the "average intelligence." We must get our story across to this diversified audience.

We should strive for clarity of explanation. "But my testimony is clear. It is always well organized. Reason after reason is put forward in a logical, orderly way. Each fact is carefully explained. My illustrative photographs are well

chosen to tell a necessary part of the story. I speak clearly, enunciate properly, and can be heard by all who should hear me. I not only strive for clarity, I achieve it." Fine, if true. Some of us hit the mark, but have you ever listened to the testimony of another expert? Did his? If we could listen critically in each case to ourselves, would our testimony measure up to the standards we believe we are attaining?

We should strive for simplicity—simplicity of presentation, of explanation, of language. Have not we achieved this in part at least by good organization of testimony? Yes, but do we express ourselves simply, concisely? It is easy enough to use one hundred words where ten well chosen ones will do. Have we kept our language down-to-earth, explained each technical term clearly? Our laboratory assistants or fellow experts may congratulate us when we step down from the witness stand on how simply we explained the findings. But what about that young fellow from the law office who brought in some papers for the attorneys and stayed to listen to our testimony? What did he think of it? After all, number six juror and he have a lot in common. Did he understand what was meant by a trauma, by a striation, by pen pressure, by colloidal suspension, by electrophoresis? If not, then possibly some of the jurors did not. Simplicity of explanation and of language is not necessarily easy for the technical witness.

Effective testimony discusses the problem, the reasons, the findings, thoroughly. Thoroughness must be related to the pertinency of the testimony. Some direct testimony of an expert may run for an hour or more, but were all its details necessary? Unfortunately, expert testimony occasionally wanders from pillar to post, discussing all sorts of tests that have no bearing on the conclusions. Negative tests may be important, but inconsequential details drag out testimony and lose the attention of the listener, the jury. Too little detail leaves the full story untold; too much, bores. Where to stop is a delicate decision.

Important points in the testimony should be properly emphasized. One of the most significant, of course, is the basic opinion. Skillful repetition of this opinion in the course of the direct testimony can do much to focus the jurors' attention on it. Each point in the reasoning that leads to the opin-

ion should be related to it and evaluated in respect to it. Likewise, by illustration, by proper use of the voice, by gestures, by diagrams and sketches, other significant facts can be highlighted.

To strive for fairness sounds paradoxical. We are engaged by one side of the controversy—prosecution, plaintiff, or defense. Our findings favor those who call us or we would never be in the courtroom. We believe in our findings—are sold on their accuracy. And yet we must present them fairly, not pro-prosecution, pro-defense. Two things must be remembered. First, our responsibility as an expert witness is higher than to our clients; an expert assists the court and jury by explaining and interpreting technical evidence. This requires a scientific attitude. Second, in our laboratory we have met each factor, pro and con, and if our opinion is right, those adverse factors were insufficient to lead us to a different opinion. Should they be disregarded, denied, suppressed before a jury? If so, they may come out on cross-examination, not only revealing the fact but also the partisanship of the witness. If an adverse factor is there, face it. A fair presentation is a scientific one and an effective one.

Essential as all of these elements are, we have all heard expert testimony which contained them and still was not really effective. Why? Because it did not have that sparkle and color necessary to hold the jurors' attention. Somewhere the witness lost his "captive audience." They became bored, daydreamed, thought about evening plans, wished that he would finish.

We as witnesses can do well to study the successful TV performers, actors, preachers, lecturers. Some of their techniques can be adapted to court presentations. Probably we should have just a touch of the ham actor in us, but just a touch, mind you. Our presentation should be lively, stimulating, down-to-earth, conversational, and certainly natural. Some indifferent witnesses speak in a dull monotone without any "change of pace," but the most successful gives an animated, almost dramatic presentation. The latter witness knows when a little humor is needed, when a courtroom sketch done before the jurors will hammer a point home. It is this latter type of presentation which all of us can use more fre-

quently. Since the advent of photographs, courtroom-made illustrations have been dying out. But look at your TV, at an animated weather report, for instance, in which pressure areas and wind directions are put on the map by the announcer. Surely this could be done more accurately before the telecast, but would the program have the same appeal? And so it is with courtroom demonstrations. Effective testimony must not be dull and monotonous regardless of its content. It must have life and naturalness—it must keep the audience concentrating on it.

We must believe in our findings. If we do not make the court and jury feel that we are 100 per cent sold on our opinion, we have failed for testimony is subtle salesmanship. All of these elements mixed in proper proportions should lead to more effective testimony.

What Should We Avoid?

There are many faults of testimony, large and small, that the experienced witness will learn to avoid. However, only three of the more basic ones need be cited here.

Despite the witness' extensive knowledge of his subject, he must certainly avoid an air of superiority. Such an attitude can ruin the best testimony. Rather, by complete familiarity with his subject he can gain the respect of those who hear him without any special display on his part. An air of friendliness and co-operation, never one of condescendence and indifference, should be developed. Thus, the jury will be won over, not lost.

Good testimony should read well in the record as well as sound well in the courtroom. Indefinite references to exhibits and parts of them must therefore be avoided. Pointing to an exhibit without describing it in words or without designating it by exhibit number may be clear to those in the courtroom, but even these listeners may misunderstand the exact reference or fail to gain the full import of the point. Reading the record afterwards, as an Appellate Court may do, finds the testimony confusing and almost devoid of meaning.

Don't over-testify. Experts, practically all of us, are too long winded. We try to include too much. Don't labor individual points. As we have warned before, don't put in incon-

sequential details. Occasionally, with a document comparison chart containing several similar points of identification, one or two will not be explained by the witness. Jurors have been known to comment after the conclusion of a case that the omitted comparison was the best and most convincing. Was it not that they themselves had a chance to apply techniques already described? Would it have been as effective if it, too, had been explained in detail like those before? There is a knack to sensing when to cut planned parts of testimony, of stopping at the right point.

How Can We Achieve More Effective Testimony?

It should be the aim of every witness to constantly improve his testimony. Even should he achieve perfection, it is not easy to maintain this high level. How can we improve or maintain consistently high standards?

Study the art of testimony as completely as the technical phases of a specialty. One very helpful way is to read transcripts of our testimony. Such a critical review may have a very sobering effect on our ego. Did we really express our thoughts so poorly here? Why didn't we amplify these ideas? Thus, we can recognize some of our mistakes—omissions and commissions. This is necessary if we are to eliminate them and improve our testimony.

The courtroom is the best laboratory in which to learn to testify. No one can learn to act from books. He must enter the theater, observe others, be a part of it. So too, with testimony. In the courtroom we can observe all kinds of witnesses at work. Lessons can sometimes be learned from the most unexpected sources. But we must be alert to our opportunities. We must not only look for new ideas, but watch for weaknesses in the testimony of others. It is a great deal simpler to spot the other fellow's mistakes than our own. But we too may be doing these same things. Are we? Do you know a good witness, an observant person, one who will speak out frankly? Take him to court when you are to testify. Possibly your pride will be hurt, but your testimony can improve if you heed his advice.

Our voice is our most effective tool in the courtroom. One who has not had voice coaching cannot appreciate how much improvement can be made. How many little, sometimes big

things are wrong with his voice. Singers who depend on their voices for a livelihood constantly train under supervision. Many excellent public speakers do too. Some even started out with bad voices, indifferent presentations. So much can be achieved with a well developed voice and speech. The expert witness can do well to study voice, diction, and speech. If he does, his effectiveness in the courtroom is almost certain to be improved.

Many times testimony is treated indifferently. Proper preparation is not made before trial. There is no rehearsal. It has been said that forty hours of preparation are necessary for many one-hour TV programs. Do we put anything near this amount of time on preparing testimony in an important case? Some witnesses do! They may write out key portions of their testimony, review it, rework it. It may actually be rehearsed either in the privacy of the witness' study or before one or more critics. Tape recording devices can be used to advantage in preparation of testimony. With experience it may not be necessary in every case to rehearse in detail, but the best testimony is achieved only with great thought and planning.

Conclusions

Effective testimony is an art, an art which through the alertness of the witness can be developed. Possibly some good witnesses are born good witnesses, but most become proficient through their own efforts.

Certain religious bodies advocate periodic self-examination, confession. Whether or not you are one who practices this discipline in relation to spiritual and moral matters, self-examination has value. For the witness, critical self-analysis is bound to lead to improvement. Only by going over parts of testimony again and again before taking the stand, by re-evaluating that which has been given, and by ever striving to improve it, can effective testimony be achieved.

With expert findings presented as they should be, cases will be won which should be. Justice will benefit, and we will function more fully as forensic scientists.

Examiner of Questioned Documents
15 Park Row
New York City 38, N. Y.

Adapting Testimony to Jury Trials*

Donald B. Doud, Milwaukee, Wisconsin

In many ways expert testimony before a jury requires different methods than trial before the Court. Most judges are experienced in listening to technical testimony and ordinary court procedures are second nature to them. But the average juror does not have this experience. He is in a foreign land. He may never have been in a courtroom before, and the profession of questioned document examination is probably an unfamiliar one. His language understanding may be limited, and the adaptability of his eye to noting fine distinctions between like and unlike objects may be almost nil. For that reason several important precautions should be observed in testimony before a jury. They are:

1. Use the most simple descriptive terms. When technical nomenclature is absolutely necessary, explain the term fully in every-day language.
2. The use of exhibit numbers is frequently confusing to the lay juror. It is well to refer to documents by identity as well as exhibit numbers. For example, "On this chart I am directing attention to the questioned will signature at the top, to Exhibit A. Underneath are 10 genuine signatures of John Brown which are numbered in evidence here as Exhibits 1 through 10.
3. Do not have a jury look through a binocular-microscope or use other complicated, difficult-to-use equipment. They will hardly ever admit failure in the use of such instruments, and may even get an erroneous impression of the evidence.
4. Jurors are sometimes influenced by the physical appearance of the witness and have been known to decide cases on such superficialities. Nevertheless, it is contingent upon the expert to be neatly dressed, to conduct himself with decorum while in the presence of the jury and to

* Presented at the section on questioned documents, Annual Meeting of the Academy of Forensic Sciences, February 23–25, 1956, Chicago, Illinois.

stay apart from the parties to the action as much as possible.

5. Make photographic charts as simple as possible. A series of charts, each one of which incorporates only three or four comparisons, is immensely more understandable than a single chart with twenty to thirty comparisons. Captions should be explained fully.

   When bromide enlargements are used, a pointer is effective in holding the jury's attention to the particular point being discussed. Hand charts should only be distributed one at a time and then picked up so that the jury will always be looking at the right chart at the right time.

6. The witness chair is no place for a quiet, mealy mouthed performance. The witness should talk loud enough so that the last person in the last row of the spectators bench can hear clearly. By this criterion, even the most hard-of-hearing on the jury should hear most of the testimony.

It is said that the average juror has the mentality of a ten-year-old child. This is probably somewhat of an exaggeration; but, be that as it may, testimony should be so simple and understandable that a ten-year-old child could grasp the significance of the testimony.

312 East Wisconsin Avenue
Milwaukee 2, Wisconsin

Extra Compensation for Expert Witnesses

George E. Hall, J.D., Chicago, Illinois

Dr. Wilson, an orthopedic surgeon, was called to the hospital at 3:30 one morning to treat a serious accident case. Open reduction, steel pins, full casts, long convalescence—just about everything that science has discovered—had to be utilized to effect recovery. In a subsequent suit, the surgeon

was called as a witness to tell about the patient's injuries, treatment and prognosis. He was in court for about two hours. Was he entitled to a greater fee than the eyewitness who was standing in his front yard and who told of how the accident happened?

Dr. Tennyson, a neuropsychiatrist, was asked to appear in the case as an expert witness. Before appearing he spent many hours examining and questioning the patient and administering various mental tests. For these services, and his subsequent testimony he was promised a fee of two hundred dollars. Was this an enforceable agreement? Could he recover a reasonable compensation for such preparatory work if he neglected to make an agreement prior to testifying?

Mr. Shelton, a handwriting expert, was promised a fee for testifying if the plaintiff won the case. Could he enforce this agreement?

Dr. Morton performed a post-mortem examination. In a subsequent murder trial may he be required, without extra compensation, to describe the nature, character and probable effect of the deceased's wounds?

Mr. Jones, a well-known ballistics expert, was subpoenaed as a witness. Was he required, pursuant to this subpoena, to make the special tests necessary to qualify himself as a witness?

The trial of a lawsuit is essentially a search for the truth. Through centuries of experience, the law has developed the ground rules designed to reveal, during a trial, the facts which are necessary for a determination of that truth. The presentation of these facts to the fact-finding body—be it the trial judge or the jury—depends in great measure upon the testimony of witnesses. Primarily these witnesses are of two kinds, ordinary or expert, the difference depending upon the type of testimony they give. The ordinary witness testifies about facts, what he saw, what he did, what he said, what he heard, what he smelled, what he felt—never what he thought. The expert witness, however, is supposed to think because his reason for testifying is usually for the purpose of stating an opinion. Obviously, therefore, a greater—or at least a different—responsibility rests upon the expert witness than upon the ordinary witness. Is he entitled to be paid more than the

ordinary witness to compensate him for his additional knowledge and additional responsibility?

Before attempting to discuss this question, one or two rather pertinent observations should be made about the duties and compensation of ordinary witnesses, because the members of our Academy, in spite of their advanced knowledge and qualifications, must often testify merely as ordinary witnesses.

It is an inherent power of a court of justice within the geographical confines of its jurisdiction, to compel witnesses to appear before it and to testify concerning relevant facts within their knowledge. Conversely, all citizens owe a duty to the state to aid in the due administration of government and they may be compelled to appear and testify even in the absence of a statute making specific provision for compensation. This is because the administration of justice is a source of mutual benefit to all the members of a community. Each citizen's time in so testifying may be claimed by the public as a tax paid by him to that system of law which protects his rights as well as those of his fellows. Most states do have statutes granting ordinary witnesses a small compensation, but such statutes are not a necessity.

Why is this of interest to a group of experts? The reason is this: the mere fact that a person is an expert does not mean that every time he appears in court he is doing so as an expert witness. When the expert is merely testifying to facts within his knowledge—without expressing any opinion concerning those facts—and even though he would not know and understand the facts if it were not for his extra learning—he is acting as an ordinary witness and is entitled only to whatever fees have been provided for such ordinary witnesses. For example, a physician who has treated a patient is testifying as an ordinary witness when he tells of how he examined the patient, what he observed as to his condition, what he did to the patient by way of treatment. A pathologist who has made a post-mortem examination may be compelled, as an ordinary witness, to testify as to facts observed by him and the result of the examination. It should be noted, however, that even an ordinary witness may sometimes be permitted to make a contract for extra compensation. For example, if he is outside the jurisdiction of the court (living in

one state and the suit is in another so that a subpoena will not reach him) he may make a valid contract to be paid for appearing. Or if he has plans to leave the jurisdiction and agrees to forego those plans. Or if he lives far enough away so that he could give a deposition but he agrees instead to appear in person. In spite of these exceptions, the general rule is that an ordinary witness may not contract for more than the statutory fee for appearing as a witness and there are court decisions to this effect in Connecticut, Illinois, Massachusetts, Missouri, Nebraska, New York, North Carolina, Pennsylvania and possibly other states.

The question of the compensation of an expert, as distinguished from an ordinary, witness is even more complicated. In the first place there are some states in which a witness who appears in answer to a subpoena as an ordinary witness may, if he qualifies as such, be also required to testify as an expert. Judging from reported cases, this is apparently true in Alabama, Arkansas, California, Colorado, District of Columbia, Georgia, Idaho, Illinois, Indiana, Kansas, Minnesota, Missouri, Nebraska, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Dakota, Texas, West Virginia and Wisconsin. These cases actually represent what is referred to as the general rule, namely, that an expert witness is not entitled to extra compensation for any testimony which he may be required to give under an ordinary subpoena of the court, in other words, for testifying to facts within his knowledge, although it may have required professional study, learning or skill to ascertain them.

There are two principal exceptions to this general rule. The first relates to instances in which the expert, in order to prepare himself for testifying has had to undertake some extra preparation. This may involve a special examination of a party to the lawsuit, the performance of certain laboratory procedures, an inspection of premises, or the like. Court decisions of Alabama, Arkansas, Illinois, Kansas, Massachusetts, Maine, Missouri, New York, Pennsylvania, Texas and Wisconsin illustrate this exception and permit an expert witness to be paid for the time necessary to perform these additional functions and to testify in court concerning them. Furthermore, it would appear that in Colorado, Illinois,

Massachusetts, Michigan, New Jersey, and New York, where witnesses must testify as experts once they are subpoenaed, nevertheless a pre-trial agreement for the payment of extra compensation may be enforced. And in Wisconsin, at least a reasonable compensation will be allowed even if none has been specified in a previous contract. In any instance in which a witness is employed to perform services requiring him to equip himself with knowledge by research or inspection, the employment will be controlled by the ordinary rules of contract express or implied. Furthermore, it should be pointed out that though a witness, once in court, must sometimes give expert testimony, he cannot be compelled to undertake special preparation in order to be able to testify. If the expert is acquainted with the facts, even though on the basis of professional study, learning and skill, he is not entitled to demand extra compensation before testifying. If he has no such knowledge however, he cannot be forced to obtain it.

The second exception to the general rule exists in those states which have enacted statutes specifically relating to the payment of witness fees to those testifying as experts. Such statutes permit the payment of special fees to experts under specified circumstances in California, Colorado, Connecticut, Delaware, Florida, Iowa, Louisiana, Maine, Michigan, Minnesota, North Carolina, Rhode Island, South Carolina, Vermont, Wisconsin and Wyoming. These statutes vary considerably, however, some of them applying to all opinion or expert witnesses, some applying only to court appointed experts, some being applicable only in criminal cases. The statutes in Alabama, Indiana and Montana deny any additional compensation to experts.

Finally, it must always be remembered that any agreement to pay witness fees, whether for an ordinary witness or an expert witness, which is in any way contingent upon the winning of the lawsuit is invalid and void as against public policy and is unenforceable in every jurisdiction.

In conclusion it might not be inappropriate to turn for a moment from "what is" to a brief speculation as to "what might be." In a sense, the expert finds himself on the horns of a dilemma which must somehow or other be reconciled. On the one hand, justice must be available to the rich and the

poor alike. It would be a sad day for our civilization if success in a lawsuit were contingent upon the relative financial status of the parties, with victory going to the litigant with the most money. Necessary proof to ascertain truth must be available to all. On the other hand, persons who possess special knowledge and abilities in the many scientific fields which exist in our society have only attained that knowledge and those abilities through the expenditure of their personal time and fortunes. They have done so because they have a thirst for knowledge above and beyond that of their fellow man, but also because they expect thereby to provide a higher standard of living for themselves and their families. In other words, they expect to receive, and should receive, compensation from persons who seek the benefit of their additional knowledge. It would be fine if the concept of "the reasonable fee" would solve the problem. Unfortunately, however, what is reasonable to the expert might still be oppressive to the litigant—and what is reasonable to the litigant might be an insult to the expert. There are those who will say "Let's pass a law" and perhaps a law permitting the court to fix a reasonable fee in each case, which would then be taxed as costs or charged against the proper party, would be the answer. But would the expert and the court agree any better than the expert and the litigant? The individual members of this Academy might well give some thought to the situation in their own states to determine whether or not the best answer may be found in legislation.

In the final analysis, however, it would seem that a solution must be reached through the mutual co-operation and understanding of lawyers and the several categories of experts. No expert wants a failure of justice to be blamed on him. Least of all does he want it said that a person with right and justice on his side lost a case because an expert refused to testify unless a big fee was paid him. Actually, it is probably not a fee for testifying that he wants nearly as much as a fee for the necessary time spent in qualifying himself to be a witness. Lawyers must realize that these outside activities, the examination of a patient, the performance of laboratory techniques, the inspection of premises, the collection of specimens, and the like, take time. They must educate their clients to

the responsibility for paying for this time and insist upon their doing so. The growth of such organizations as the *American Academy of Forensic Sciences* and the spirit of friendship engendered by the members of the various sections meeting and thinking together about their common problems are a big step in the right direction. Joint medicolegal institutes are another. *The Journal of Forensic Sciences* is still a third. We must not close our eyes to the fact that the great majority of scientific problems which arise in the administration of the civil and criminal law and require the services of expert witnesses can be handled by the members of our Academy. We cannot let society down by pricing our services out of the market. We must voluntarily reconcile our duty to society and our duty to ourselves and our families, or it will be done for us and possibly in a manner not to our liking. To the extent that we do this we will obviate the need for restrictive legislation, preserve our own integrity and protect the system of jurisprudence upon which our society is based.

Summary of general rules:

1. Ordinary witnesses—General Rule	entitled to no more than the statutory fee even though he has expert qualifications, unless he is out of the court's jurisdiction or unless he gives up a valid right and agrees to testify, etc.
2. Expert witnesses—General Rule	entitled to no extra compensation for testifying to facts within his knowledge even though it may have required professional study, learning or skill to ascertain them.
3. First exception—	when he is obligated to perform some special tests, examinations, inspections, etc., before testifying.
4. Second exception—	when there is a specific statute relating to expert witnesses' fees.
5. Basic qualification—to all general rules and exceptions	no agreement for extra compensation of either ordinary or expert witnesses is valid if it is in any way contingent upon the outcome.

REFERENCES

1. Morgan, William G.: Expert Witness Fees, Journal of Criminal Law and Criminology, Vol. 43, March–April, 1953.
2. Bomar, Horace L., Jr.: The Compensation of Expert Witnesses, Law and Contemporary Problems, Vol. II, No. 4, October, 1935.
3. Long, Rowland H.: The Physician and the Law, Appleton-Century Crofts, Inc., 35 W. 32nd St., New York 1, New York.
4. Annotation in 2 American Law Reports, 1576 et seq.
5. Annotation in 16 American Law Reports, 1457 et seq.
6. Discussion in 56 American Jurisprudence, 503 et seq.

Staff Associate, Law Department
American Medical Association
535 North Dearborn Street
Chicago 10, Illinois

Answering the Cross-Examiner on Expert Witness Fees

Donald B. Doud, Milwaukee, Wisconsin

"Mister Witness, how much are you getting for testifying in this case?" This is a question the expert witness hears in many different degrees of innuendo on cross-examination, and one that is a source of irritation to the fair-minded, scientific practitioner. Obviously, the intention is to minimize or discredit the expert's testimony because he is being paid for his services. While it is nonsensical to assume that a professional man should not be paid for his services in any legal matter, as he is in his usual professional capacity, some lawyers try to establish a doubt as to the witness' reliability by implying that he is "for sale" to the highest bidder. If dealt with by the expert in a flippant or evasive manner, this is unfortunately the impression sometimes carried into the jury room.

In attempting to offer some solution to this problem, I would like first of all to discuss the two fundamental questions which have essential bearing on the matter as a whole. They are:

1. What is a reasonable fee? What is the basis for expert charges in any particular matter?
2. What are the legal precedents allowing cross-examination on expert witness fees?

With respect to the first problem, it is manifest that the expert witness should be adequately compensated for his work. For the most part, this type of witness is a professional man who has spent many years in study, research and practical application of his knowledge. The highest value must be placed on this training because it is this that distinguishes the professional man—the expert if you will—from the ordinary unskilled person.

The setting of expert fees should, in my opinion, take into consideration the following factors:

A. THE AMOUNT OF TIME CONSUMED ON THE CASE

The time spent on any case includes all examinations, research, study, conferences and travel time, together with time spent on the witness stand.

B. OFFICE EXPENSES AND MATERIALS USED IN CASE

Office overhead, of course, varies with individuals and occupations; however, all phases of these expenses such as rent, light, secretarial services, etc., should be considered.

Materials used in the investigation would include x-rays, test chemicals or drugs, special research equipment and similar investigational media.

C. FINANCIAL SACRIFICE INCURRED IN ATTENDING THE TRIAL

In some instances, other paying work, including office appointments, must be sacrificed in order to attend the trial. Also to be considered is the location of the trial, whether in town or in some other city.

D. CUSTOMARY FEES

A common denominator for judging expert witness fees is the amount charged by other equally experienced men in the same profession.

E. THE IMPORTANCE OF THE CASE AND THE RESPONSIBILITY ASSUMED BY THE EXPERT
This is a question of some delicacy because the importance of any litigation naturally depends somewhat on the amount involved. More important, however, is the fact that important matters require important decisions and a greater responsibility on the part of the expert witness. The professional man of the greatest experience and reputation is usually engaged in these matters, and the outcome of the case depends much on his ability in presenting his evidence. He should be well paid for these services.

But what is a reasonable fee in these times? As a general rule, it is poor practice for any professional man to undercharge. The professional who undervalues his services and charges small fees because of a fear that he will offend the client, may, in doing so, hurt his own prestige immeasurably. His modest fees may be attributed to inexperience, lack of reputation, or second-rate work.

Using document examiners as an example, a general rule is that a fee range of $75.00 to $150.00 per day for office work is not out of line in these inflationary times. Overtime or Sunday work is, of course, billed at a higher rate. A fair charge for court work would be $150.00 to $300.00 per day, depending upon the circumstances as heretofore outlined and the location of the trial. It is the practice of some expert witnesses to charge separately for the original examination and report as distinguished from the trial preparation (including charts and questions and answers for the attorney) and testimony. When the original opinion is negative, the second phase of the case is, of course, unnecessary.

It is the general practice in most jurisdictions to allow questioning of the expert witness on the amount of his fee. This matter, however, generally appears to be left up to individual courts. In an Illinois case,* the court gave the following decision with respect to this question:

> It has been held that while the compensation paid an expert witness and the circumstances of his employment

* People v. White, 365 Ill. 499, 6 N. E. 2d 1015 (1937).

> are not controlling and do not necessarily discredit the witness, yet these are facts which are proper to go to the jury, to be considered by them with the other facts and circumstances in evidence, in determining the amount of credit to be accorded the testimony of such witness. A professional expert witness should not be a partisan. His function is to give truthful testimony upon and about the matters upon which he may be interrogated. His sphere is not that of an advocate for the side of the controversy by which he is employed. Accordingly, it is proper to cross-examine a questioned document expert concerning the compensation he expects to be paid for his services.

How are we going to take the sting out of cross-examination on our expert fees? To the ordinary lay juror accustomed to making perhaps $12.00 or $15.00 or $25.00 per day, an expert fee of $150.00 may seem outrageous and exorbitant. On the theory that foresight is better than hindsight, one means of circumventing this type of questioning on cross-examination is to meet the matter head-on on direct examination. For example, in answer to a direct question put to him following his main discussion of the evidence, the witness can frankly discuss the basis for his fees, such as the amount apportioned to travel expense and to materials and whether this is a customary fee in the profession. This type of frankness hurts the "below-the-belt" type of attorney who loves to imply that he is digging something unpleasant out of the witness. It will aid the jury in realistically appraising the fee to the effect that $150.00 per day will be considered fair and reasonable, as it should be.

In cases where the matter is left to cross-examination, and the usual question is asked, "Mr. Witness, how much are you getting for testifying in this case?" the following rejoinders are direct, proper, and to the point:

A. "I have been paid $100 for the many hours spent in investigating this problem, and naturally I have not rendered a bill for testimony until my work is finished."

In some cases I have included in the foregoing a statement something less than responsive, but quite effective:

A. "Mr. Counsel, I would not be down here at all testifying in this case if I had rendered an opinion adverse to my own client, as I do in about 50% of my other cases."

When no fee arrangement has been made, which is the case with employment by former clients and reputable law firms, an effective answer is:

A. "Mr. Counsel, I expect to render a fair and reasonable bill at the conclusion of this case. I have not totaled up my time in examining the evidence, nor do I know how long I will be in court."

If an hourly or per diem rate has been quoted, the following answer may be given:

A. "My fees are based on the usual professional rate of $20.00 per hour, of which over half will go to my overhead expenses."

This latter statement may not be responsive to the question and probably would be stricken from the record. This is not of great importance as long as the jury has heard the expert's answer. Redirect examination is another means of enlarging on the fee question if some misconstruction has been placed on the expert's statements on cross-examination.

In answer to the most vicious type of cross-examination frequently encountered, it is, in my opinion, quite permissible to answer in a direct manner. Some lawyers will say to you, "Mr. Witness, you are being paid for coming down here to prove this man guilty, aren't you?"

A. "No, sir, I am down here to prove the facts and unlike you, Mr. Counsel, I must believe what I say."

Or, it may be answered as follows:

A. "I do not like the insinuation in your last statement, but I would be glad to discuss with you for the jury to hear the exact basis for my employment in this matter."

The final question, and one that needs very little enlargement, is the matter of contingency fees. A fee arrangement taking into consideration the outcome of the case, absolutely

is not recommended for any professional testifying as an expert witness; so questioning or cross-examination concerning this matter can honestly be answered thus:

A. "Mr. Counsel, I do not work on a contingency fee arrangement; I expect to be paid for my services, whether or not the case is won."

The admonition "Forewarned is forearmed" generally sums up the necessary attitude of the expert on fee questioning. Most good lawyers do not consider it necessary or proper to go into matters of fees on cross-examination. However, with those who do, a direct frank statement will be the last thing they expect and will take the sting out of cross-examination on fees.

312 East Wisconsin Avenue
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ANNUAL MEETING

AMERICAN ACADEMY OF FORENSIC SCIENCES

Drake Hotel, Chicago, Illinois, February 28, March 1–2, 1956

General Sessions—Section Meetings

Pathology—Toxicology—Immunology—Psychiatry—Law—

Questioned Documents—Police Sciences

Toolmark Identification

Emmett M. Flynn, Chicago, Ill.

In modern scientific crime detection there are numerous procedures for identification that can be used to assist the police investigator. One of these aids is the criminalistic science which is known as toolmark identification. In the discourse concerning an unusual case in this article, consideration will be given to this interesting phase of police crime laboratory work. The importance of this type of identification lies in the fact that it can be an element, not only of burglary, but of any type of crime.

Toolmark identification concerns itself with identifying a specific tool as one imparting a particular mark. This is accomplished by the matching of class and individual characteristics of impressions and striations imparted by a suspected tool with the markings on relevant objects found at a crime scene. Identifications of this type may be established by cutting test standards on soft metal, lead, clay or other suitable media with the tool in question and comparing these marks with markings on the submitted evidence. This evidence usually consists of such items as jimmied door locks, cash boxes, parts of safes, etc.

Testimony concerning toolmarks will be accepted by the courts, provided it is well presented by qualified witnesses. Many convictions have been obtained with this evidence. One of the most famous was the conviction of Bruno Richard Hauptman in the Lindbergh baby kidnapping case (1). The identification of wood from Hauptman's attic as being the same wood that was used in the kidnap ladder by means of annular growth rings and planer markings, was a deciding factor in the "guilty" verdict of this case.

The writer has testified on toolmark identification to help secure a conviction in a recent burglary case wherein three burglars were caught near the scene of a burglarized apartment building. Markings made with the screwdriver recovered from one of the suspects at the time of the arrest were identified with markings on a metal door lock striker plate from one of the jimmied doors in the apartment building.

Burglar tools that can be effectively identified usually fall into three main categories. There are "jimmy" tools such as pry bars and screwdrivers; cutting tools such as bolt cutters and knife blades; and pressure tools such as hammers, drift punches, etc. However, one other type of burglar tool that can be placed in either of the above categories, depending on the way it is used, and one which will be considered in our first of two case illustrations, is that which is known as a lock puller.

A lock puller is a pincer type instrument that is used to pull lock cylinders out of their anchored receptacle in a door lock and thereby enable easy access to entry by exposing the inner locking mechanism.

The photographs in Figures 1, 2, and 3 represent the use of a lock puller on a door lock cylinder in an actual case. As the illustration indicates, the chipped edge of the pincer jaws of the lock puller tool fits smoothly into the cut section of the lock cylinder ring. There are class characteristics here and also some good individual characteristics. But is this enough to enable a positive identification? Could one be sure that no other tool in existence could have a chipped edge similar to this one? If the illustration were enlarged 100 times, would it be found that the fit was not as perfect as it is seen here due to elasticity and "bouncing" of the metal? Would there be gaps between evidence and tool? Although in this particular case it was not necessary to measure microscopic tolerances, what is the scientific basis for an opinion to identify this tool as the one causing this particular impression? As corroborative and confirmatory evidence, this would be excellent, but what if this were the only evidence that one had in an important murder case. Would it be enough?

Fig. 1—View showing lock puller tool in question and lock ring that fits over ordinary door lock cylinder.

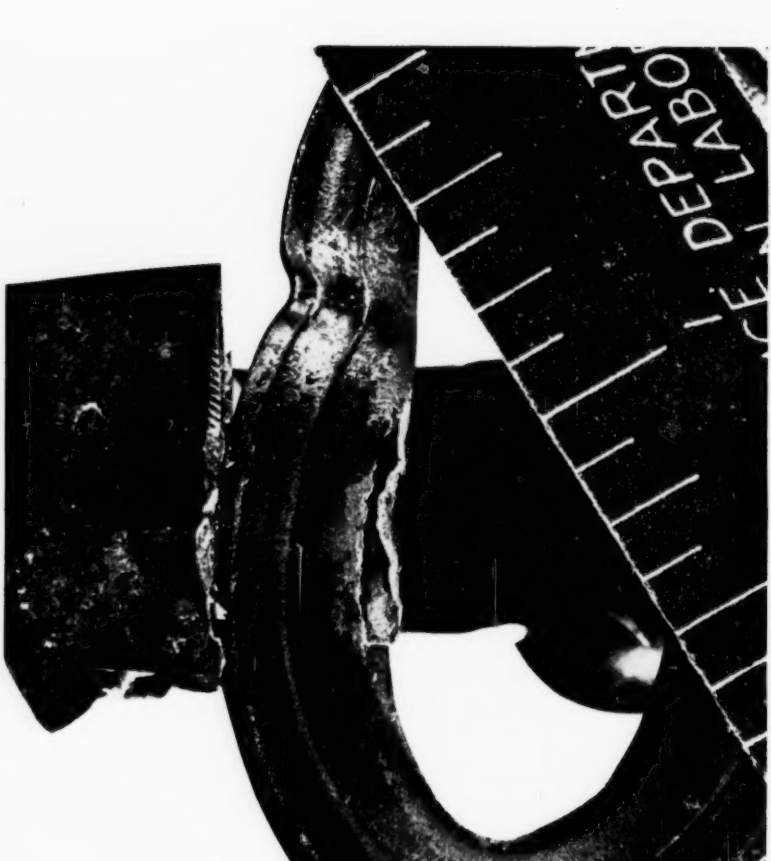

Fig. 2—View showing evidence impression in lock cylinder ring (bottom) and chipped edge of lock puller jaw (top).

Fig. 3—View showing how chipped edge of lock puller jaw fits perfectly into jagged cut in the evidence lock ring.

A certain number of points of similarity are necessary for fingerprint identification. How many points are needed for a positive identification for toolmark evidence or any similar science other than fingerprints? In a toolmark identification photomicrograph, should there be 10 microscopic striations or comparable characteristics that match side by side, or should there be 15, 30 or 200? This is a matter upon which experts in the field have not as yet reached full agreement.

To avoid possible confusion, it should be stated that the basic purpose of these questions is merely to stimulate thinking and thereby help establish a greater scientific basis for toolmark identification by promoting wider research, co-operation and progress among those in the police science and investigation field.

To form a basis in scientific fact, the following experimentation was performed. One hundred chisels were selected that had been manufactured in immediate numerical sequence. It was shown by examination and testing, that in the final grinding process, there were produced different and definite individual characteristics on the cutting edge of each chisel that could be identified with that tool and only that particular tool. This was due to microscopic granular changes in the material of the grinding wheel, caused by wear, and the metal structure of the tool edge. This research project originated with Chicago Police Crime Laboratory personnel and was initiated by Charles W. Zmuda, (2), a former member of this laboratory.* The writer, a former associate of Charles Zmuda, carried on this experiment by making the necessary comparisons over a period of time.

The comparisons of tests revealed that no two of the chisels made the same marking. This was proven by cutting test standards on 2″ x 2″ x 1/8″ lead squares with each of the 100 chisels. The same angle was used with all conditions being equal for each test impression. None of the test standards matched with any of the other 99. In making these comparisons, it must be realized that the first test standard had to be compared with 99 others. The second test standard had to be compared with 98 others, the third with 97 others

* Now associated with the Dade County Crime Laboratory in Miami, Florida.

and so on. This is a decreasing arithmetical progression represented by the simple formula ($S = \frac{a + l}{2} \times n$) * and reveals that the above experiment with just 100 chisels amounts to 5,050 different comparison combinations. This indicates a basis of substantiation that the same marking will not recur again as applied to the law of probabilities.

In addition to the above experiment, a duplicate chisel-striae test standard was cut with one of ten different chisels and then inserted in the group with the striation tests of these ten chisels, making a total of eleven test standards. Its position was unknown at the start of the comparing of these tests. They were then compared with each other, one by one, to see if this duplicate test standard could be detected when it was arrived at, to check the alertness and procedure of the operator. This duplicate test standard was easily found and positively identified with the other of these two identical test standards.

Returning now to the question of what one would decide in this particular lock puller case, it may be restated, that this is excellent supporting evidence. This is especially true in this particular case where there were statements of witnesses as to the suspect being present at the scene at the time when the burglary was committed. There are also the good matching characteristics of a three-dimensional nature, with the broken jaw edge of the lock puller fitting perfectly into the jagged cut in the lock ring, with the exact corresponding angle of curvature. Although the microscopic striations that appear in an ideal type of identification were not present in this case, there is enough unusualness about these characteristics for the examiner to venture an opinion that this pincer jaw caused the impression on this lock ring. The probability that another pincer jaw would chip in exactly this same way; that the jagged edge on the lock ring would be torn in just the way it is so as to fit the chipped jaw; and that this lock puller should be recovered from the suspect at the time and near the place where the crime was committed, all make for an estimated high probability that all

* S = sum of n terms; a = first term; l = last (or nth) term; n = number of terms.

this would not recur again. A satisfying conclusion to this case was the entry of a plea of guilty by the accused after being confronted with this evidence.

Consideration will now be briefly given to a case in which an ideal type of positive identification may be made, as referred to previously. This would be a case in which the estimated probability of recurrence is extremely remote and can be said to parallel fingerprint or firearms identification. This is an identification where, in addition to class characteristics, there are also a good number of individual characteristics or microscopic striations. Such a toolmark identification is shown in Figures 4 and 5. Figure 5 in this case illustrates the matching characteristics, wherein test standards of striae made on lead with a screwdriver recovered from a burglar suspect, were matched with "jimmy" markings on a burglarized apartment door lock. It is a photomicrograph at 22 x magnification showing the matching characteristics of the 1/4" wide screwdriver blade that was used. The individual characteristics match and align with each other along the entire width of the impression to prove that the screwdriver in question caused the toolmark on the evidence. There are a good number of matching points illustrated in this identification.

Having observed two actual cases, some conclusions and comments can now be made concerning the future of toolmark identification evidence and any limitations that it may have. As for the limitations, it must be realized that the characteristics of a tool will change with use. When a tool is submitted for examination, the cutting edge should be carefully protected against damage and corrosion; and it should be submitted as soon as possible after commission of the crime.

There appears to be no standard magnification that may be adhered to for toolmark comparisons. In case work done at the Chicago Police Scientific Crime Detection Laboratory, similarities of individual characteristics have been demonstrated and photographed at 50 x magnification; an example of which was a fingernail clipper that was used to cut metal seals on coin boxes. Magnifications as high as 75 diameters have also been used to show similarities of class and individ-

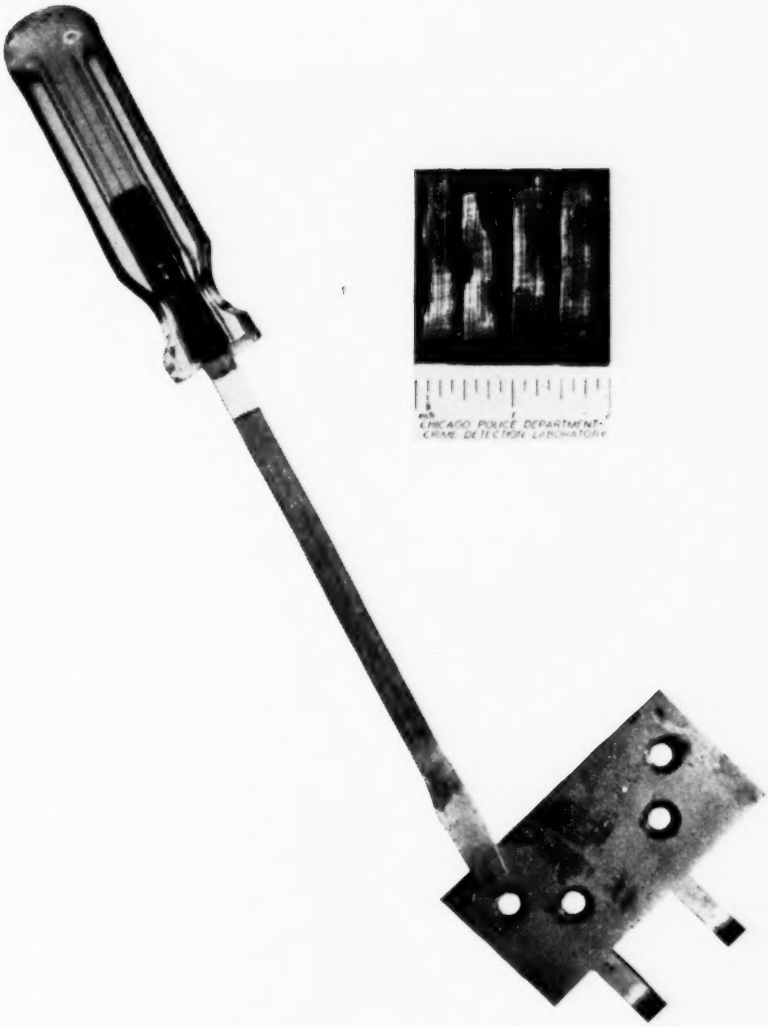

Fig. 4—View showing screwdriver used, part of evidence door lock containing toolmarkings, and 2" x 2" x 1/8" lead test standard on which striae markings were imparted with the screwdriver shown, to be compared with the striae marking on the door lock evidence.

Fig. 5—Comparison photomicrograph at 22 x magnification showing striation markings on test standard (left), matched with striation markings on the door lock evidence (right), proving that the same screwdriver made both.

ual characteristics in scratch markings on railroad seals, that were opened by use of an ordinary pin. This may not always be possible due to the type of metal or material on which the mark may appear and also on the conditions pertaining to the use of the tool; but it illustrates what can be done in the nature of toolmark identification.

It must be remembered that the upper limit of magnification depends on certain conditions. The field of view at a particular magnification, coupled with the importance of obtaining an over-all picture covering the complete width of the particular toolmark, are controlling factors. More important, however, is the quality of the toolmark evidence and how much appears in the impression in the way of microscopic striations or unusual characteristics that may be reproduced by the tool for identification.

Indications are that toolmark identification will come into its own more and more as a method of crime detection and that its scientific basis will be more firmly established. There are some, even in the forensic sciences, that know little about this type of work and its advantages. One of the apparent reasons behind this is that toolmark identifications are one of the most difficult to make and often require considerable patience on the part of the examiner. In what can be called its parent science, "Firearms Identification," a test bullet matches with the evidence or it may not. The same is true of fingerprints and other identification sciences. However, in toolmark work the angle at which the tool was used must be duplicated in the test standard, pressures must be dealt with, and the degree of hardness of metals and other materials must be taken into account.

Stereo-photography or three-dimensional representation may be helpful in tool identification. The advantages would be that in addition to showing a flat two-dimensional view of the matching characteristics, a third dimension can represent the depth of each rise or depression of the striae markings to show a profile type view and illustrate how these are identical also. This could demonstrate the probability against recurrence more effectively.

While the foregoing article is not intended to be complete coverage of the science of toolmark identification, the writer

hopes that it will have contributed toward the development of this branch of criminalistics.

Summary

This article is an introduction to the criminalistic science of toolmark identification. Actual burglary cases involving the use of a lock pulling tool and a screwdriver are discussed, illustrating two types of identification.

A completed research project is described with accompanying results that should help to form a greater foundation for toolmark identification. Some comments are also mentioned concerning toolmark work and what has been done in this field.

REFERENCES

1. Koehler, Arthur: Technique Used in Tracing the Lindbergh Kidnapping Ladder. Journal of Criminal Law and Criminology, 27:712, 1937.
2. Zmuda, Charles: Identification of Crepe-Sole Shoes. Journal of Criminal Law, Criminology and Police Science, 44:374, 1953.

Scientific Crime Detection Laboratory
Chicago Police Department
Chicago, Illinois

Seminar in Forensic Pathology*

*Conducted by Russell S. Fisher, M.D., and Richard Lindenberg, M.D., Baltimore, Maryland***

Foreword

This seminar was presented, not so much as one of difficult pathologic anatomy problems, but rather to illustrate and emphasize the medicolegal problems arising as a part of post-mortem examinations in cases of forensic interest. For this reason, a brief clinical summary and photomicrographs of the essential pathology are presented, the questions raised are posed and these are followed by opinion of the discussant in each case.

Case 1. Etiology of Liver Necrosis

This 29-year-old man was shot in the right chest while he was a bystander in a gun battle arising from a "crap" game. He was brought to the accident room of a hospital where examination showed a gunshot wound of the right chest with intrathoracic hemorrhage. This was aspirated. He was given a bottle of plasma. No surgery was done. The next day he signed his own release from the hospital but returned from time to time to the Out-Patient Department. The last visit was three weeks after his injury. He reappeared at another hospital 62 days after his injury complaining of vomiting and pain in the abdomen. On admission, he

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* Beginning with the present issue of Journal of Forensic Sciences, and continuing in subsequent issues, there will be published several reports of the seminar in forensic pathology, presented by Drs. Fisher and Lindenberg at the North Central Region Meeting of the College of American Pathologists, November 20, 1954, Chicago, Illinois.

** From the University of Maryland School of Medicine, Division of Legal Medicine; the Department of Mental Hygiene, State of Maryland and the Office of the Chief Medical Examiner, State of Maryland, Baltimore, Md.

was slightly jaundiced and exhibited tenderness in the right upper abdomen. Laboratory tests indicated marked impairment of liver function. He died 30 hours later. Post-mortem examination showed a well-healed bullet wound over the third right intercostal space just lateral to the sternum. The right lung was free in the cavity. The bullet was found in the right pectoral muscle in the axilla and there was no evidence that the bullet had, in fact, penetrated the pleural cavity. The lungs weighed 1375 grams and there was extensive aspiration of "coffee ground" material in the air passages. The liver weighed only 800 grams. It was remarkably flabby, tending to flatten out completely when placed on the table. The capsule was loose. The cut section was friable with blurring of the lobular pattern. The color was a peculiar golden. The stomach showed an area of superficial ulceration in the fundus and the GI tract contained liquid and clotted blood with approximately a pint of "coffee ground" material. The significant pathology is shown in Figures 1, 2 and 3.

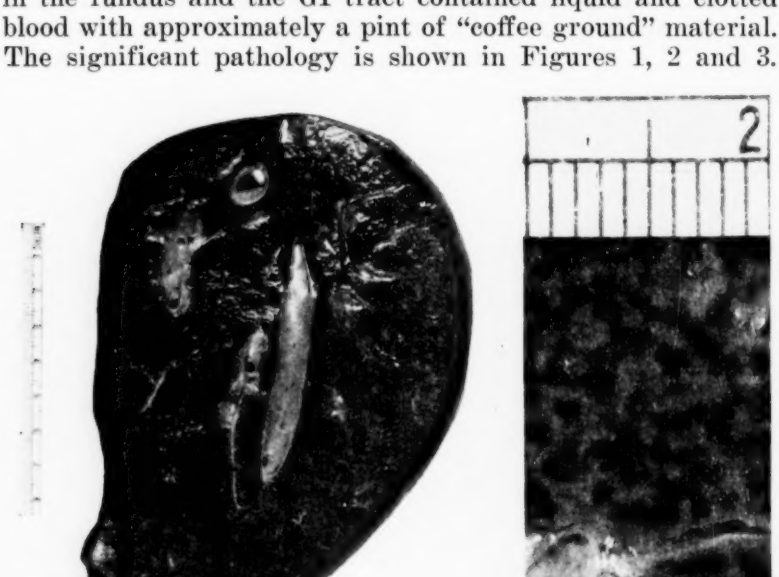

Fig. 1—Liver showing mottling due to extensive necrosis.

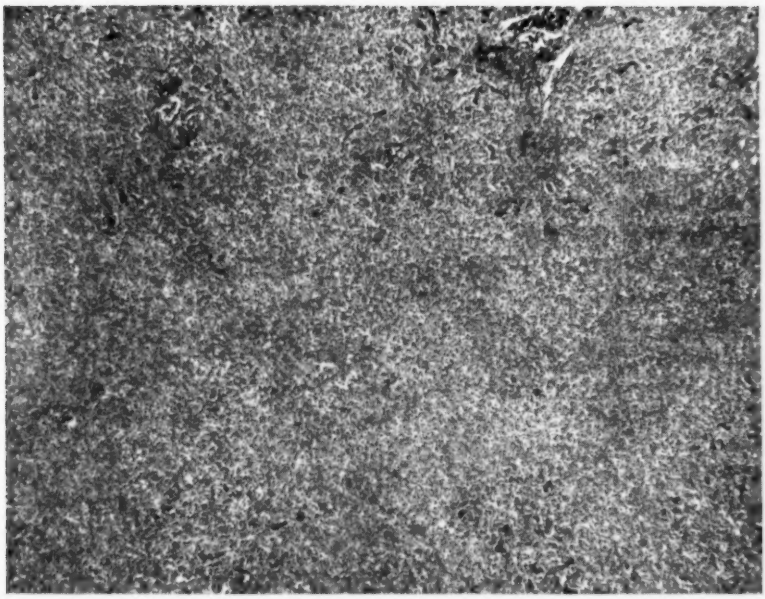

Fig. 2—Histologic section of liver showing complete disorganization with minimal hyperplasia of bile ducts.

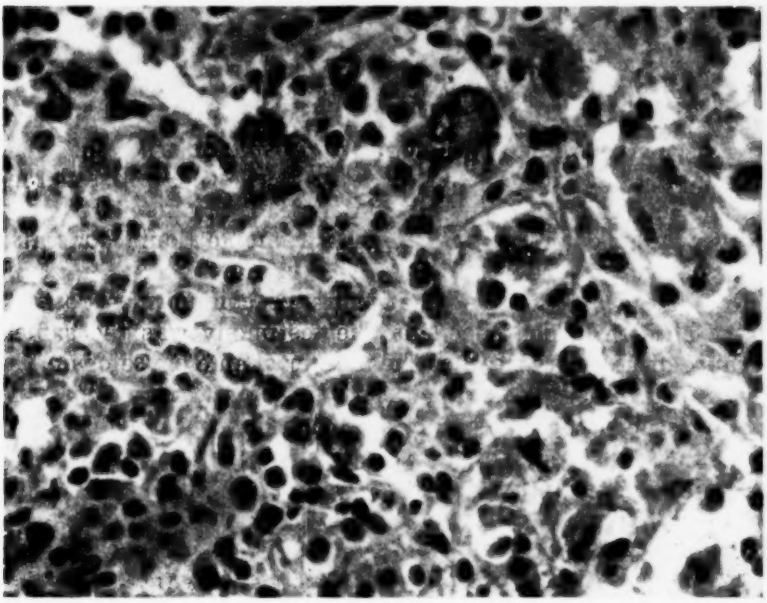

Fig. 3—High power of an area of the necrotic liver. Note the mixed exudate and the early bile duct proliferation.

The liver showed advanced necrosis with the retention of the bile duct elements only. The process was most advanced in the central zone. There was a prominent mixed leukocytic infiltrate. The kidney showed cloudy swelling and degeneration of tubular epithelium with albuminous and basophilic debris in many of the tubules.

The Medicolegal Problems: (1) What was the diagnosis? (2) You are called upon to testify in a criminal case in which the individual who fired the gun has been indicted for murder of the deceased. How will you testify in regard to the relationship between the gunshot wound and this man's death? (3) There is also a suit pending against the insurance company because the company has refused to pay an accidental death benefit due the man's widow. What will your testimony be in this case?

Discussion: (1) The diagnosis was acute yellow atrophy of the liver, most probably a fulminating homologous serum hepatitis. It is impossible to rule out infectious hepatitis.

(2) I would testify that the probable cause of this man's death was homologous serum jaundice, a complication of the plasma transfusion required in the treatment of his gunshot wound. However, it must be added that there is "reasonable" doubt in this regard, since there was some infectious hepatitis occurring in the city during the time between this man's injury and his death and pathologically I could not rule out such a disease. On this basis the state's attorney nol-prossed the murder charge, since it was evident that the medical testimony would not support "beyond reasonable doubt" a traumatic cause for the death.

(3) In the suit against the insurance company in regard to the accidental death benefit, the testimony was the same. Because of the wording that the most probable cause of death was infectious hepatitis and that this, though a rare complication, is nevertheless the natural consequence of being given plasma for a gunshot wound sustained wholly from external and violent means, the testimony would be in favor of the plaintiff indicating that there was a connection between the injury and the death. A court ruling which is pertinent to the above description is in Parsons v. State, 21 Ala. 300

where, in the case of an injury followed by a therapeutic misadventure and death, the court stated that "where a wound which was mortal or dangerous was inflicted, the person who inflicted it cannot shield himself under the pleas of erroneous treatment." Also in Powell v. State, 13 Tex. App. 244, the court held that "where death ensues from a wound given in malice, but not in its nature mortal, but which being neglected or mismanaged, the party died therefrom, this will not excuse the party inflicting it; but he will be held guilty of the murder, unless he can make it clearly appear that the maltreatment of the wound, or the medicine administered to the patient, or his own misconduct, and not the wound itself, was the sole cause of death."

Case 2. Aggravation of Disease by Injury

This 44-year-old male city employee was said to have been breaking up ice on a city street when he fell and struck his head above the right eye on the curb. He sustained a laceration which required sutures. He was allegedly unconscious for an unknown duration of time, certainly not more than one hour. This accident occurred six months before death. He returned to work but complained of headaches which persisted until his death. One month after the accident, he had a grand mal epileptic seizure. This recurred once every two weeks and was treated conservatively. Five months after the accident, he developed anorexia, lost weight, and became progressively weaker. Two weeks later, the headaches became more severe and nuchal rigidity developed. At the same time, he became progressively confused. Shortly before admission to the hospital, he suffered an epileptic seizure, and this lasted one hour. At admission, his temperature was 103° F., pulse 90, blood pressure 150/110. He was confused, disoriented, restless. A pneumonitis and signs of meningitis were found. A lumbar puncture revealed CSF pressure of about 600 mm. H_2O. The CSF was xanthochromic and contained 134 lymphocytes. Pandy was 3 plus. Acid fast bacilli were seen in one smear. X-rays of the skull were negative. Chest showed infiltration at right costophrenic

angle. The patient died 24 hours after admission and six months after the accident. A tuberculous meningitis was suspected. However, a subdural hematoma was also considered as a possible cause of the clinical symptoms.

The autopsy revealed a pulmonary tuberculosis. There was no trace of subdural or subarachnoid hemorrhage. The brain showed no evidence of a former trauma. There was a severe swelling with flattening of the convolutions and compression of the brain stem. The main lesion in the brain was located in the left frontal lobe. It is shown in Figure 1. The tissue slide selected for this seminar represented this lesion and surrounding brain tissue.

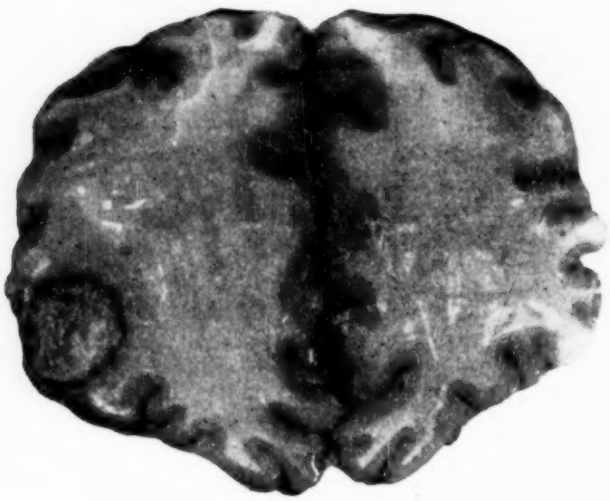

Fig. 1—Tuberculoma in sulcus between left third frontal convolution and orbital convolutions. Swelling of brain.

The Medicolegal Problem: The histologic features of the main lesion leave no doubt as to its specific character. During a suit for compensation, questions arose as to whether or not there was any causal relationship between the brain lesion and the former head injury. What would your testimony be in this regard?

Discussion: The main lesion constituted a medium-sized tuberculoma (about 2 cm. in diameter) within the sulcus between the third frontal and the orbital convolutions of the left side. It involved cortex and white matter of the third frontal convolution and was associated with a more recent, diffuse tuberculous meningitis. The tuberculoma revealed no unusual histologic features. There was some loss of nerve cells in its vicinity and some of the remaining nerve cells demonstrated fresh, necrobiotic changes. Some vessels adjacent to the tuberculoma, especially one larger branch of the middle cerebral artery, showed angitis with destruction of their walls and marked narrowing of their lumens. Such vascular changes are common in cerebral tuberculosis and often cause areas of softening which may produce not only local neurologic phenomena frequently seen in tuberculous meningitis but also contribute to the fatal increased intracranial pressure by causing swelling as in the present case. In the entire area near the tuberculoma there were no former traumatic alterations in the brain or in the subarachnoid space. The ultimate cause of death was a severe swelling of the brain initiated by the inflammatory process and exerting pressure on vital areas.

An analysis of the causal relationship between the brain lesion and the head injury can be only a theoretical one in the present case. Before discussing the various versions of their relationship, it is necessary to ascertain how severe the head trauma was in regard to the brain and how long the tuberculoma had existed.

The head trauma obviously caused a short-lasting unconsciousness but was not sufficiently severe to cause a fracture of the skull or hemorrhage into the subdural or subarachnoid space or into the brain. Not a trace of former traumatic damage could be found within the contents of the cranial cavity.

As to the age of the tuberculoma, its histologic features do not indicate whether it was a few weeks or a few months old. However, its location within the brain is such that it must be considered responsible for the epileptic attacks mentioned in the clinical history. Since the first major seizure occurred 4 weeks after the injury, the tuberculoma must have been present by that time. Therefore, it is very probable

that it either started to develop or was already present at the time the accident occurred. In view of the absence of traumatic alterations this is the only explanation for the persistent headaches following the accident.

Four theoretical versions of the causal relationship of the trauma and the tuberculoma must be considered:

(1) The trauma may have initiated the formation of the tuberculoma.
(2) The trauma aggravated an already existing tuberculoma.
(3) The tuberculoma precipitated the accident.
(4) The tuberculoma and the trauma are causally unrelated.

As to the first version, it is known that an injury may initiate a tuberculous meningitis. However, this is possible only if an existing tuberculous lesion was directly or indirectly exposed to the mechanical force. Because of the traumatic damage to such a lesion, a dissemination of tubercle bacilli may occur, causing among other inflammatory responses, a meningitis (1). In the present case the injury under consideration is one to the right forehead. This, per se, could definitely not cause the tuberculous lesion. It could be argued, however, that the head injury was only the most obvious sequela of the man's fall but was not the most decisive one. Considering the fact that the man had a pulmonary tuberculosis which very likely was already present at the time of the accident and assuming that not only the head but also the chest was concussed in the fall, it could be theorized that a traumatic involvement of the pulmonary lesion led to a liberation of tuberculous bacilli into the blood stream and thus to the cerebral tuberculoma. Whether the location of the tuberculoma was determined by a traumatic locus minoris resistantiae or was purely incidental would not alter the fact that the trauma of the chest by liberating the bacilli, caused the tuberculosis of the brain. The before-mentioned assumption of a chronological coincidence of the fall and the development of the tuberculoma would certainly favor such theory.

The second version of the causal relationship of the trauma and the tuberculoma is highly questionable in view of the slowness with which the clinical phenomena developed and of the long survival.

As to the third and fourth versions, it would be necessary to secure more detailed information on how the accident took place before giving an opinion. This additional information became available when the Compensation Commission heard testimony. It was found that, contrary to the statement made by his family that he fell and struck his head while at work, he was, in fact, in a building warming himself up during a rest period when he suddenly staggered, fell and struck his head on a radiator but did not sustain any impact to the chest or fall to the floor. This disposed of the possibility of relation of injury to disease as discussed in the above first version. It was concluded that a fainting spell or perhaps the first epileptic attack caused him to fall and that his spell was a result of the tuberculoma. Therefore, the Compensation Commission did not have to face the issue of the relationship of the injury to the subsequently demonstrated tuberculosis, both because his disease was already present at the time of the accident, and because his fall did not "arise in the course of and as a result of his work."

The case was selected for this seminar in order to demonstrate the great significance of securing a complete and accurate history of an accident before giving any opinion as to relationship of accident and disease in a compensation case.

Case 3. Alleged Toxic Effect of Therapy During Treatment

The deceased was a 50-year-old white female storekeeper who sustained a gunshot wound of the back during a holdup of her store. There was a large wound extending from D7 to D9, three inches to the right of the midline, with many puncture wounds in the middorsal region. She was paralyzed from that level down. On admission to the hospital, her blood pressure was 130/70, her weight 170 pounds. The wound was cleaned and packed and she was treated for support of the paraplegia. Sixty-five days after the shooting, she complained of "substernal pain on deep breathing which sug-

gested pleural involvement." There was a cardiac murmur and minimal changes in the electrocardiogram, interpreted as due to possible patchy or subendocardial necrosis. An order for atropine sulphate grs. 1/150 every six hours was written. Following this administration and on successive days, she developed recurrence of the substernal pain and difficulty in breathing. The atropine was continued. Two days thereafter, she had recurrence of substernal pain and had dysphagia and vomiting. Ten days after beginning the atropine therapy, she became excited, disturbed and agitated with marked personality changes. That night she became unresponsive. It was noted that she had complained of nausea and dryness of the throat and that the blood pressure was 210/110, pulse 140. Examination showed a delirious patient who responded to commands but said no words. The pupils reacted sluggishly and were slightly dilated. The patient was cold and sweaty with a weak thready peripheral pulse. The atropine was discontinued. Within hours, the temperature rose to 105.6° F. She developed retinal hemorrhages. There was extensive rigidity of the left arm. The following day, the temperature rose to 106° F. and she expired. The autopsy showed an emaciated body weighing 100 pounds. There was a defect in the skin of the back at the site of the gunshot wound. The chest showed organizing fibrous adhesions between the medial surface of the left lower lobe and vertebral column at the level of the defect in the skin which, however, was covered by the muscle. The heart weighed 290 grams and showed no gross abnormalities. The lungs weighed 980 grams and showed a few shotgun pellets in the left lower lobe, posteriorly. The tracheobronchial mucosa was reddened. There was a moderate amount of mucopurulent fluid within the bronchi. The spinal cord showed atrophy of the cord in the thoracic region. Analysis of a mixed sample of liver and brain was reported to show 40 micrograms of atropine per one hundred grams of tissue. The illustrations portray the acute bronchitis and early bronchopneumonia found throughout the lungs and an area of scarring in the septal myocardium. The etiology of this is unknown but it considered as the explanation of the ECG changes noted during the patient's illness.

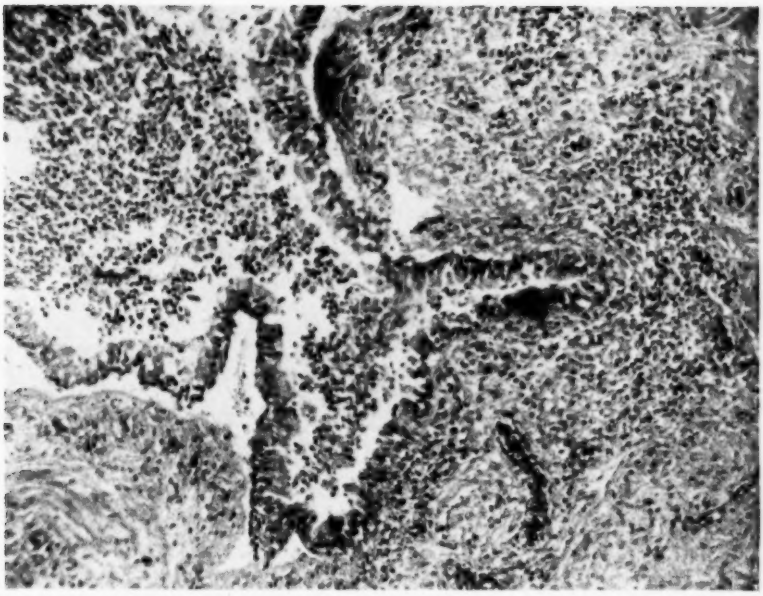

Fig. 1—Photomicrograph showing purulent bronchitis which in many areas was complicated by bronchopneumonia.

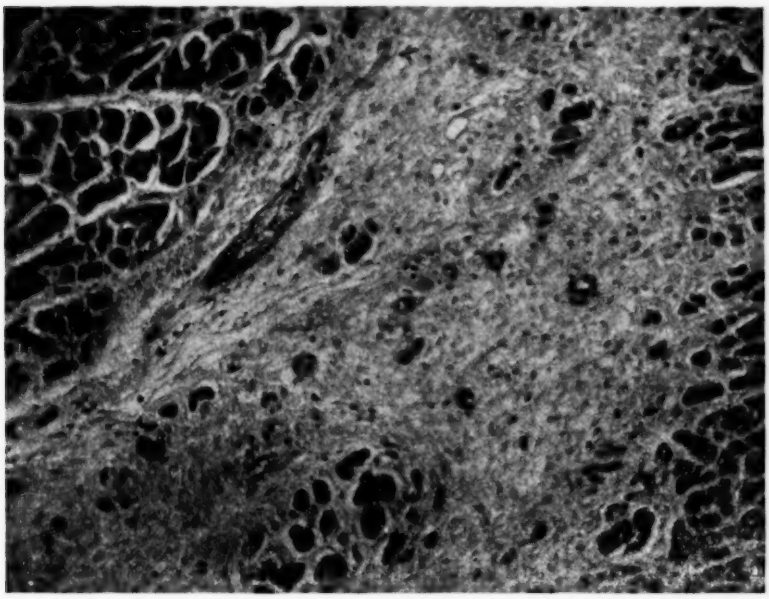

Fig. 2—Myocardium showing nonspecific scarring which probably accounted for the ECG changes and clinical cardiac sypmtomatology of the patient.

Fig. 3—Low power magnification of dorsal spinal cord showing extensive destruction of cord due to shotgun injury.

The Medicolegal Problems: (1) How would you sign the death certificate? (2) What is the relationship of the atropine administration to death? (3) How would you testify to the grand jury considering the indictment of the assailant who shot the deceased? (4) How would you testify in the malpractice case, should one arise, in which it is alleged that atropine contributed to the death?

Discussion: (1) The findings of the post-mortem examination of an early bronchopneumonia and a severe bronchitis were regarded as the terminal event. The death certificate was signed—Primary Cause of Death—bronchopneumonia and atropine intoxication due to gunshot wound of the back with transsection of the spinal cord.

(2) The relationship of the atropine adminstration to the death is debatable. There are many authorities who state that the amount of atropine administered to this patient is not a fatal dose. There are also cases in the literature where

huge doses of atropine have been used with anticholinesterase poisoning. These probably have little bearing on the present case, since the atropine administered in anticholinesterase poisoning cases is directly antagonized by the anticholinesterase agent present. It is clear, however, that this patient exhibited signs of atropine toxicity. It remains an insoluble pathologic problem as to whether the bronchopneumonia, which was probably the important terminal cause of death, was caused by or accelerated by the respiratory tract changes due to atropine over-dosage. This was a very troublesome case to the writer and the matter has, therefore, been referred to many authorities for opinion. In summary, opinion is divided.

(3) In regard to the testimony for the grand jury concerning the indictment of the assailant who shot the deceased, the medical examiner testified that the gunshot wound initiated the series of events which led to the death, that the wounds in and of themselves were mortal, that the patient's severe weight loss and general inanition confirmed this and that although there was an unsolved problem in regard to the importance of the atropine contribution, it remained true that the primary factor causing the death was the gunshot wound inflicted during the committing of a felony. An important legal decision bearing on this case is State v. Karsunky, 197 Wash. 87, 84 P. (2d) 390, 396, where the court stated "If one unlawfully inflict upon the person of another a wound calculated to endanger or destroy life, it would not be a defense to a charge of unlawful homicide, where death ensues, to show that the wounded person might have recovered if the wound had been more skillfully treated. Even unskillful or negligent treatment of the wound on the part of the wounded person or his physicians, which may have aggravated the wound and contributed to the death, does not relieve the assailant from liability. He must, as we said in State v. Baruth, 47 Wash. 283, 91 P. 977, 983, '. . . show that the negligent and unskillful treatment was the sole cause of death, before he can escape the consequences of his unlawful act on this ground.' "

(4) In regard to the malpractice case which arose in connection with the atropine administration, it is the writer's

opinion that there is little to support such action. In the first place, solution to the question as to how much the atropine contributed to the death is purely a matter of opinion rather than fact. In such cases the benefit of the doubt should certainly go to the physician who acted in good faith in treating the patient. It should be considered that the physician gave large doses of atropine approaching the point of toxic effect with full knowledge of the effects and potential toxic reactions but that this was of the nature of a calculated risk, since the atropine effect was desirable and the deteriorating condition of the patient warranted vigorous therapy. Another interesting point in this regard is directed to the 40 micrograms of atropine per 100 grams of tissue. It seems improbable that this analysis, despite this quantitative report, should be accepted as such. Our toxicologist, who has subsequently repeated the same analytic procedure on various unknowns, has found a wide variation in the quantitative recovery of atropine with an error which might even approach + 50%. This indicates that the true concentration of atropine may have been considerably less than that reported and introduces further doubt that atropine contributed, to an appreciable extent, to the death.

Case 4. Cardiac Arrest Under Anesthesia for Treatment of an Injury

The deceased, a 29-year-old female, was a passenger in an auto struck by another vehicle. She was admitted to the hospital a few hours after the accident in a semiconscious state with multiple contusions and lacerations of the face and head. The lower jaw showed bilateral fractures and the left tibia was fractured obliquely in its middle third and minor displacement of the fragments. An X-ray of the skull did not reveal any fracture of the cranial bones. There were no other abnormal physical findings, including the heart. Shortly after admission, the teeth were wired, and a Kirschner wire was inserted in the left tibia under sodium pentothal, nitrous oxide and ether anesthesia. Upon completion of the operation and removal of the endotracheal tube, the patient was reacting and coughing with a good cough reflex. Soon

afterwards, she developed apnea, showed evidence of laryngeal spasm, and the heart stopped beating. Immediately, a thorocotomy was done, and after brief massaging the heart quickly picked up. Duration of cardiac standstill was not recorded in the history. A tracheotomy was performed. The patient withstood these procedures fairly well, but did not recover from her semicomatose state. Bilateral Babinski and hyperactive reflexes were found. The eyelid reflexes were present and she seemed to be able to follow moving objects with her eyes. Four days after admission, she began to run a fever, which by the 18th day, became markedly septic in character. Twenty-nine days after the accident, the patient died due to pneumonia and septicemia without ever regaining full consciousness.

The autopsy revealed an extensive bronchopneumonia. The brain showed a generalized atrophy, most pronounced in both parietal regions (Figure 1). No primary traumatic lesions could be identified grossly. The histologic sections which were submitted were prepared from the tissue block shown in Figure 2.

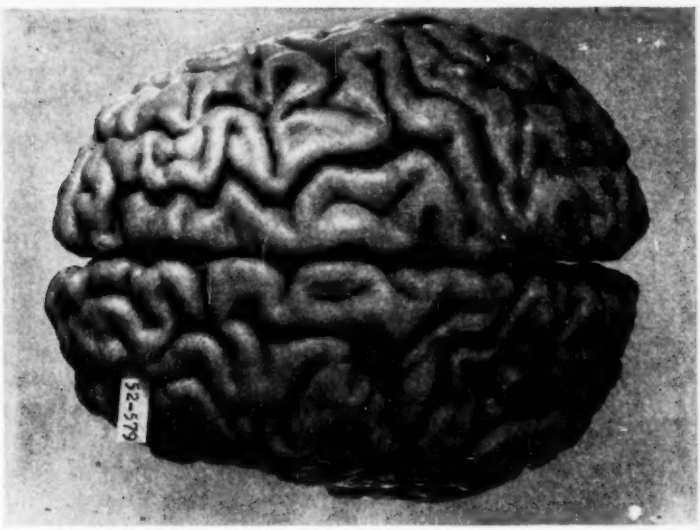

Fig. 1—Generalized atrophy of convolutions, especially in parietal regions.

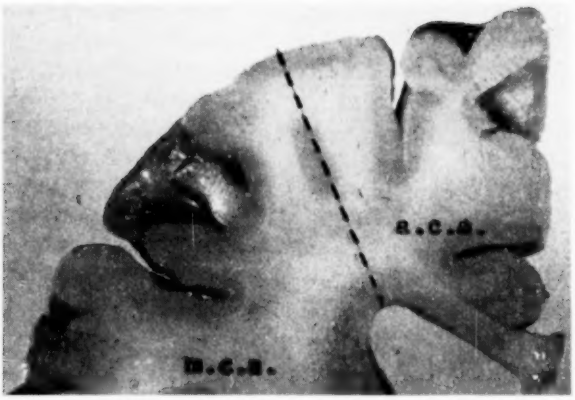

Fig. 2—Cross section through precentral portion of left frontal lobe showing the areas supplied by the anterior cerebral artery (a. c. a.) and the middle cerebral artery (m. c. a.). The dotted line indicates the border zone of the two cerebral arteries.

The Medicolegal Problems: (1) What area of the brain (frontal, parietal, occipital or temporal lobe) does the tissue section represent? (2) Can you identify the convolutions present in Figure 2? (3) What are the findings, their nature and their relation to the death? (4) What is the responsibility of the driver of the colliding car if it is shown that he was driving negligently; what about the responsibility of the surgeon-anesthetist team?

Discussion: (1) The brain section (Figure 2) was taken from the precentral portion of the left frontal lobe.

(2) It shows the corpus callosum next to it, the cingulate gyrus followed by the first, the second and the adjacent portion of the third frontal convolution.

These first two questions may appear to be somewhat elementary but they were raised for a very special reason. The brain is a large and very complex organ. If it shows grossly no obvious alteration, it is very decisive for the success of its histologic examination to select those areas for microscopic study which will most probably reveal histologic changes. In every case in which the clinical history suggests that a temporary standstill of the systemic circulation occurred, the area of the brain shown in Figure 2 should be histologically

examined in toto or subdivided in smaller blocks. If the circulatory failure lasted long enough to produce irreparable damage of nervous tissue, the border zone areas of the large cerebral arteries are, in general, the sites in which the first alterations can be expected. The tissue block in Figure 2 is a cross section of the entire supply area of the anterior cerebral artery and the border zone of the terminal branches of the anterior cerebral artery and of the middle cerebral artery.

(3) The histologic examination of the cerebral cortex reveals the following: In the cingulate gyrus (Figure 3a), there is no loss of nerve cells. Their architectural arrangement and individual structure are normal. In the first frontal convolution (Figure 3b), a loss of nerve cells can be noticed, especially in the third layer of the cortex. The small nerve cells of the second layer are relatively well preserved. In the border zone (Figure 3c), the nerve cells of all layers including the second one, have disappeared, except for some of the large pyramidal cells of the lower portion of the third layer. Beyond the border zone, the supply area of the middle cerebral artery, the intensity of the tissue damage gradually lessens again. The loss of nerve cells is accompanied by a progressive reaction of the glia. The microglia form rod cells. The astrocytes show enlarged clear nuclei and often an increase in the amount of their protoplasm. The perivascular connective tissue does not participate in the tissue reaction.

The loss of nerve cells and its accompanying glial reaction are a typical sequela of a period of inadequate oxygen supply. Such more or less selective loss of neurons is called "incomplete" or "selective paranchymal" necrosis of the brain (2). It results in an atrophy of the involved tissue and not in a tissue cyst as does the softening or "complete" necrosis. (See Supplement I: * Types of necroses due to oxygen deficiency in the central nervous system.) The peculiar distribution of the neuronal loss in the present case is related to the anatomy of the arterial system. The tissue damage is most pronounced in the border zones of the terminal branches of the arteries and gradually decreased towards

* Will appear in subsequent issue, Vol. 2, No. 2.

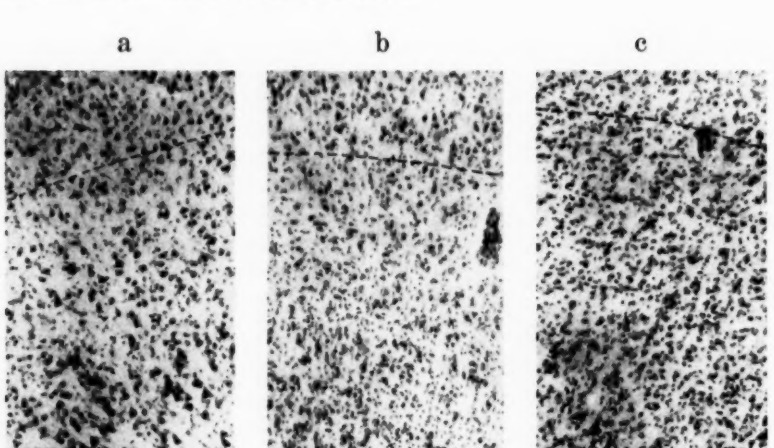

Fig. 3—Photomicrograph of second and third layers of cerebral cortex in Figure 2. a. Upper half of cortex of cingulate gyrus showing essentially no loss of neurons. b. Upper half of cortex of first frontal convolution near the midline showing severe loss of neurons in the third layer. Some neurons of the second layer are preserved. There is formation of rod cells and progressive changes of astrocytes. c. Upper half of cortex of second frontal convolution near the border zone. There is extensive loss of neurons in both the second and third layer. Only a few large pyramidal cells of lower portion of third layer are preserved. The magnification is the same in all three figures (X 100). Nissl stain.

the arterial stems. Since the arterial border zones of both hemispheres were involved in a symmetrical fashion, the loss of nerve cells must be attributed to a systemic oxygen deficiency, in the present case to the temporary cardiac arrest. In fact, in most cases with temporary cardiac arrest, regardless of its course, the tissue damage, once it occurs, shows the same distribution pattern. This indicates that during the phase of cardiac standstill and probably during the resumption of the heart action the hypoxia is not evenly distributed. The most peripheral irrigation areas of the main arteries must be exposed to greater oxygen deficiency than the areas closer to the arterial stems. This can be attributed only to an earlier and longer lasting cessation of the blood flow in the peripheral areas as compared to that in the proximal irriga-

tion areas of the arteries. In more pronounced cases, a grossly visible softening of the cortex may develop. If in a given brain there is a significant variation in the intensity of the tissue damage from one border zone to the other, it is usually due to a physiologic or pathologic variation in the caliber of the arterial stems. Since the brain may swell during and after the cardiac arrest, the swelling may also interfere with the cerebral circulation causing additional lesions. The situation may be even more complicated if space-consuming, traumatic lesions are present, because they, too, often lead to secondary tissue necrosis due to vascular compression (3). In the present case, there are no primary traumatic lesions in meninges and brain.

The extensive loss of nerve cells in the various areas of the brain discussed, including the basal ganglia, explains the permanent unconsciousness and the inability of the patient to cope with infections.

(4) There would be no responsibility of the surgeon-anesthetist team unless it were shown that they were negligent, and thereby caused the anesthetic misadventure. The driver of the colliding car, however, is responsible if it is shown that he was driving negligently, insomuch as an anesthetic misadventure is a rare but predictable complication of the injury sustained by this decedent. There are a number of court decisions on each side of the issue in similar cases. Juries may be expected to exhibit a good deal of latitude, frequently freeing the driver on the criminal (manslaughter) charge but awarding damages to the plaintiff in the civil case.

THOMAS ARTHUR GONZALES

1879–1956

Dr. Thomas Arthur Gonzales or "Tag," as he was known to his intimates and associates, died May 14, 1956 at the age of 77. He had served as the second Chief Medical Examiner of the City of New York until his retirement in 1954.

When Dr. Charles Norris, the first Chief Medical Examiner of New York City, was appointed to that position, Gonzales joined him as an Assistant Medical Examiner. He was promoted to Deputy Medical Examiner in 1926, and in 1935, when Dr. Norris died, he became Acting Chief Medical Examiner. In 1937 he was appointed Chief.

Dr. Gonzales was born in New York and was graduated from Bellevue Medical College in 1898. He was Pathologist at Harlem Hospital before his appointment to the Medical Examiner's office in 1918. He served as professor of forensic science at the New York University Post-Graduate Medical School and had also been on the faculty of New York Medical College, Flower and Fifth Avenue Hospitals and the New York University College of Medicine. He was certified by the American Board of Pathology, was a member of the American Association of Pathologists and Bacteriologists and of the College of American Pathologists. He was a member of the American Academy of Forensic Sciences.

A pioneer in the scientific investigation of suspicious deaths, as instituted by the adoption of the Medical Examiner System in New York City to replace the outmoded, politically-staffed coroner system then in existence, Dr. Gonzales was instrumental in the development of the newer methods involved in such studies. The results of these experiences are embodied in the textbook "Legal Medicine, Pathology and Toxicology," of which Dr. Gonzales was a co-author and which has become a classic for students and physicians throughout the world.

A tall, moderately obese, jovial individual, wearing horn-rimmed glasses, Dr. Gonzales was a friend to all those around him. He took great pleasure in demonstrating the pathological material from his autopsies to the students and interns in his laboratory and gave unsparingly of his knowledge to the enlightenment of all around him.

A. W. Freireich, M.D.

Book Reviews

LIE DETECTION AND CRIMINAL INTERROGATION. By Fred E. Inbau and John E. Reid. Third edition. Cloth. $5. Pp. 235, with illustrations. The Williams & Wilkins Company, Mount Royal and Guilford Ave., Baltimore 2, 1953.

The third edition of this book presents John E. Reid as coauthor with the author of the 1942 and 1948 editions, Fred E. Inbau. The text is again divided into two parts. Part I, The Lie Detector Technique, has been revised and enlarged extensively. Part II, Criminal Interrogation, presents but slight enlargement and some rearrangement which is understandable as it would be difficult to improve upon this part.

Part I presents a very complete picture of instrumental interrogation employing the polygraph. There still exists an overabundance of footnotes, many of which could well be incorporated in the text proper while others could be deleted if a bibliography were included. The historical development of instruments and techniques is interestingly described.

The test environment and pretest procedures are discussed briefly. The pretest interview and indoctrination of the subject have great bearing upon the success of the examination. Many of the difficulties mentioned in Part I can be overcome or avoided by proper conduct of this interview. This portion deserves enlarging in future editions. "Control" and "guilt complex" testing procedures have been discussed at greater length in this edition.

The "control question test" and the use of the "guilt complex" question are adequately covered. The importance of control questions as an indication of ability of the subject to react, and the fictitious similar event (guilt complex) question as an aid to chart interpretation were stressed by Leonarde Keeler to his classes. They are just as important in techniques used today.

The formulation of the test questions is briefly discussed and final instrument adjustments prior to the beginning of the actual test are mentioned. The recommended time spacing between questions is too short. Figure 9 illustrates this point as the reactions would have been lost or clouded by following questions had the recommended time intervals been employed.

The Peak of Tension Test remains the most useful of all tests. Unfortunately, material is frequently not available for its proper use. The explanation of this type of test is well presented.

Deception responses, deception criteria, and diagnostic technique receive the extensive treatment necessary. Many figures illustrate the various patterns obtained. The value of the figures would be greatly enhanced by the inclusion of the markings on the chart indicating the points where the question was begun, ended, and answer given by the subject. These markings are necessary if reactions are to be properly evaluated.

In conjunction with the section on Physiological and Mental Abnormalities it should be borne in mind that the real truth and the truth as the subject sees it may not be the same. The fantasy of juveniles which is real to them and the faulty memory for recent events in the senile must be remembered, as well as other honest errors. Control tests will usually indicate the subject unsuitable for instrumental interrogation.

The statement attributing reactions as recorded by polygraph to adrenal gland activity is not wholly true. It is the stimulation of the sympathetic nervous system by neural mechanisms which accounts for the more specific blood pressure and respiratory changes and all of the changes in sweat gland activity.

The practical value of recording muscular movements during a test is far from proven. Experiments along this line were and are highly desirable until such time as objective conclusions may be reached which take into consideration the addition of special attachments to the instrument, the special chair, and complication of the chart by additional tracings.

The Psychogalvanic Skin Reflex or Electrodermal Response in actual cases can be considered as a high level process reflecting tension or background excitement. The nature of the response being due to changes in sweat gland activity (not "sweat pores"), whether it be by skin conductance changes or changes in the production of electric currents by variations in the gland activity.

The behavior symptoms of lie-detector subjects are considered following the pertinent comment that "no specific type of behavior—even though it is highly typical of one or the other of the groups (guilty or innocent)—should be considered proof of guilt or innocence." It should be noted that the terms "guilt" or "innocence" should not be used, as the polygraph technique merely indicates truthfulness or untruthfulness of the subject's reply to the question as the subject sees the truth.

The accuracy of the polygraph technique is a matter of concern and importance to many. The figures quoted (p. 111) do not justify the percentage of error as stated. Opinions were expressed concerning 4,093 of the 4,280 subjects examined. These opinions were capable of being evaluated as to correctness in only 809 of the subjects. There were 3 errors found in these 809 opinions, a percentage of .037. The opinions expressed in over 80% of those examined were not capable of evaluation. When results can be checked in less than 20% of the subjects examined, a statement as to the percentage accuracy of the method is not justified.

The importance of "the ability, experience, and integrity of the examiner himself" is stressed and no one can dispute the necessity of these attributes. The method of obtaining formal training and the time required for satisfactory basic training from a practical point of view is in dispute.

The portion concerned with the Legal Status of the method is interesting and valuable. It also poses many questions. One wonders how many of the psychiatrists voting for the adoption of the resolution (footnote page 130) had any actual case experience with the polygraph. It seems that any person or group in discussing instrumental interrogation gives the impression of considering their own educational and training qualifications as the minimal ones for polygraph exam-

iners. This is certainly not the case as demonstrated by the results achieved in many places where the polygraph is extensively used. Neither do these same results indicate that it is necessary for an examiner to devote his time exclusively to the polygraph in order for good results to be achieved.

Part II, Criminal Interrogation, is excellent. The admonition that confession is not the end of the investigation is most timely. The laws concerning confessions should be thoroughly read and studied.

This reviewer does not like the suggestions in Parts I and II that subjects be approached by "implication or accusation of guilt," in cases where guilt is doubtful or uncertain or where the polygraph charts are merely hard to interpret, unless the examiner actually feels the subject guilty. Much can be lost by this tactic. The other approaches mentioned are just as productive when properly applied.

All persons in any field of forensic sciences, and certainly all police officers, can obtain valuable and useful information from this excellent book. It serves as a good starting point for the beginner in interrogation and as a fine review and source of practical suggestions for the experienced.

LEGAL MEDICINE, edited by R. B. H. Gradwohl, M.D. C. V. Mosby Company, 1954. 1093 pages with 222 illustrations.

While legal medicine dates from the Cain and Abel episode, its progress in these United States has been at a snail's pace. Of recent years it is gaining impetus and in several areas has expanded greatly. But by far and large the horizon is hazy. No doubt many factors have contributed to this slow advance, and it is rather astounding that colleges of medicine have not led the way; too many are content to list a short course in medical jurisprudence as their contribution to this signal science.

Excellent books on this subject have appeared in this country, but second editions are not the rule. So it is to an author's credit to overcome trepidation and doubt, and have courage to assemble material for a new volume. Dr. Gradwohl is ably fitted to take such a step. Most wisely he has not attempted to write all of it. He has chosen specialists in particular fields who he thinks are most capable and able

to impart their particular knowledge in a given area. Undoubtedly other collators would have selected different contributors. As might be expected there is considerable variation in brilliance from chapter to chapter. An international flavor is imparted by excellent chapters by Sir Sidney Smith on "The History and Development of Legal Medicine," by Francis E. Camps on "Wounds of the Head and Body and their Interpretation," by L. R. Janes on "Common Causes of Unexpected Deaths," and by W. E. Evans on "The Examination of Hairs and Fibers."

In the chapter on the medicolegal autopsy an apologia of several pages condoning embalming prior to such an autopsy because of expediency and having the embalmer "break the seal (on a bottle) and obtain the blood specimen" may arouse argument.

While the chapter on Legal Authorization for Autopsy covers all the states in outline form, the following chapter on Law Relating to Medical Practice cites court records from California, New York and Missouri only. Surely other areas have concern with this subject.

Pathology is rather well covered in a series of papers by Strassmann, Janes, Camps, Carr, Orrahood, Courville, some rather specialized, others somewhat general, but all well worth reading. The chapter on Rape is brief, almost to the point of inutility. The cliche that "Spermatozoa are shaped like tadpoles" is almost antediluvian when one considers the exquisite structure effected by modern staining methods. And neither here nor in the section on Examination of Seminal Fluid is there a picture of these cells, certainly a thing the uninitiated would look for in such a book as this.

The two chapters on Skeleton and Teeth contain considerable factual knowledge with excellent drawings and plates. The three chapters on Blood (Identification of Blood Stains, and Blood Grouping Tests in the Determination of Nonpaternity—both by the Editor; Paternity Proceedings and Blood Tests by Schatkin) form a solid triad, although one wonders why the Chaplin Case is detailed. It is just another example of the unpredictable jury ignoring scientific facts.

A considerable amount of the Section on Toxicology is from the Editor's "Clinical Laboratory Diagnosis and Methods"

although much new material is included. The portion on spectrophotometry is a most welcome addition. A separate chapter by Muehlberger on Medicolegal Aspects of Alcohol Intoxication is well done, although the Borkenstein Apparatus is not considered.

Some seventy pages are devoted to Forensic Psychiatry by Satterfield, and it is obvious that the subject cannot be presented in adequate fashion in such a space. A large bibliography is appended for those who wish to delve further into this subject.

"Narcoanalysis" by Matthews and "Lie Detection" by Lyle are cramped into forty-four pages. Perhaps such topics of controversy cannot be afforded more space in a book of this type. Other chapters on "Police Laboratory Administration," and "Legal Aspects of Trauma and Disease" are well written but submerge to too great a degree the functions and relationships of physicians to law enforcement. The Editor is to be complimented on his statement "Hospital pathologists as a rule are not properly qualified in legal work" and on his conclusion regarding the Coroner's Office and the Medical Examiner that either is good "if efficient personnel is provided."

The book is well printed and typographical errors are few. It represents an excellent start, but the subject matter is just too enormous to be compressed into one volume. It will be of value to physicians, lawyers and others, provided it is realized that there is much more to this field than can be possibly encompassed in a single volume, albeit it is as excellent as this one.

THE DENTIST AND THE LAW, by Charles Wendell Carnahan, Ph.B., LL.M., Jur. Sc.D.; Member of the State Bars of Illinois and Missouri; Professor of Law, Washington University, St. Louis, and Lecturer on Dental Jurisprudence, School of Dentistry, Washington University. Published by C. V. Mosby Company, St. Louis, 1955, 263 pages.

The dentist who has either idle or practical curiosity about the law and its relation to him in his practice has altogether too few readily available sources of information. Here is a book which helps to satisfy his desire or need for knowledge in a field other than his own. It discusses the law clearly

and with reasonable thoroughness as it concerns the dentist who is engaged in the active practice of his profession. And, it should be noted at this point, even though the book is written primarily for the dentist, it is sufficiently broad in its scope to be of interest and value to all practitioners of the healing art.

Whether it is because of the author's natural talents, his training in the law, or his experience as a teacher, is secondary to manner in which he presents his material. He offers much information in a logical understandable way. He opens each chapter with a short, general discussion of what is to be covered in the chapter. Then he proceeds to discuss, point by point, those legal principles encompassed within the outline of the chapter. Where necessary he quotes from court decisions to illustrate a point or gives citations to leading cases as authority for the principle discussed.

Coverage of subject matter is certainly adequate. He starts with definitions of law and a description of judicial machinery. He explains how the law is developed and prepares his reader for the chapters which follow on the respective duties of doctor and patient; the matter of compensation; the theory of negligence and malpractice; and the like. He discusses tort law and contract and makes clear the difference between them. He does not forget to relate his discussion to the everyday, practical problems which confront the practitioner of dentistry. Liability for injury to those other than patients and responsibility for the acts of others are given careful consideration.

One who wishes to have some acquaintance with the law without becoming an expert, one who wishes to get an overall picture of the relation of the law to the practice of the healing art can appreciate and enjoy this book. The book is easy to read. It is well indexed. it is a handy reference with practical value in everyday practice.

Articles to Appear in Forthcoming Issues of the Journal of Forensic Sciences

The Medical Expert Witness—Positive—Negative—Maybe—*Harley J. McNeal, LL.B.*

Chemical Findings in Cases of Fatal Barbiturate Intoxications—*Irving Sunshine, Ph.D., and Earl Hackett, B.S.*

Seminar in Forensic Pathology (Continuation)—*Russell S. Fisher, M.D., and Richard Lindenberg, M.D.*

A Review of the Amnesic States—The Significance of Retrospective Falsification—*Maier I. Tuchler, M.D.*

Lie-Detector Test Limitations—*Fred E. Inbau, B.Sc., LL.M.*

The Stepdaughter Paraphiliac Neurosis—*George N. Thompson, M.D., and W. B. Whann, A.B.*

Death by Hanging of Adolescent and Young Adult Males—*Richard Ford, M.D.*

Administrative Procedure and Scientific Evidence—*Sidney B. Schatkin*

Treatment of a Borderline Case with Group Analytically Oriented Psychotherapy—*Donald A. Shaskan, M.D.*

Seminar on Testimony—Questioned Document Section—*Ordway Hilton, M.A.; David J. Purtell, Ph.B.; Harry M. Ashton; C. D. Brooks, B.S.; and Donald Doud*

Fatal Air Embolism Following Intrascrotal Injection in a Transvestite—*Lester Adelson, M.D.*